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Alberta

OIL SANDS TECHNOLOGY
AND RESEARCH AUTHORITY

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Alberta
OIL SANDS TECHNOLOGY
AND RESEARCH AUTHORITY

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TO HER HONOUR
HELEN HUNLEY
LIEUTENANT GOVERNOR OF THE PROVINCE OF ALBERTA

Madam:

I have the honour to submit the Annual Report of the ALBERTA OIL SANDS TECHNOLOGY AND RESEARCH AUTHORITY for the fiscal year ended March 31, 1989.

Respectively submitted

RICK ORMAN
Minister of Energy

Foreword

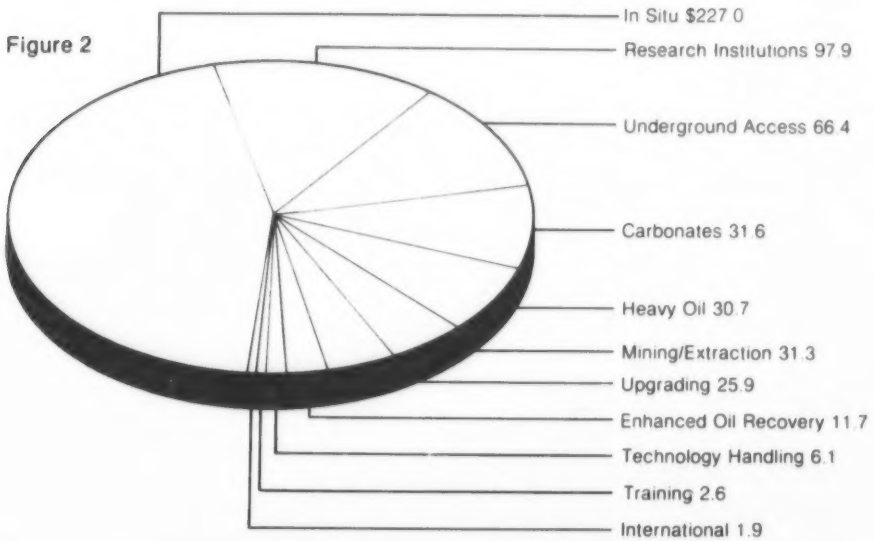
On January 14, 1974, The Premier of Alberta announced the availability of $100 million to develop new technology for the recovery and processing of petroleum from the Alberta oil sands. The terms and conditions for the disbursement of these funds are described in the Oil Sands Technology and Research Authority Act, passed by the Legislature in June 1974 and since amended to include the recovery of heavy oils and the enhanced recovery from conventional petroleum reservoirs. Additional funds have since been dedicated by the Alberta Government to permit the funding of longer term programs.

AOSTRA Field Pilot Projects

Figure 1

Commitments from AOSTRA Research Fund To March 31, 1989 ($ Millions)

Figure 2



Report of the
Chairman and Chief Executive Officer

To the Honourable Rick Orman
Minister of Energy

Dear Mr. Minister:

I have the honour of presenting the Annual Report of the Alberta Oil Sands Technology and Research Authority (AOSTRA) for the fiscal year ended March 31, 1989.

During the 1988/89 fiscal period AOSTRA's extensive ongoing and new programs were financed by an approved Capital budget of 36 million dollars. Administrative expenses were budgeted at 3.4 million dollars. The budgetary allocations permitted considerable advancement and success in all areas of AOSTRA endeavours. In situ oil sands recovery development progressed and continues to be encouraging. The AOSTRA - Amoco - Petro-Canada pilot project at Gregoire Lake continued operations using steam and steam combined with additives. Operations which began in 1986 will continue through 1989. The AOSTRA-Bow Valley Cold Lake pilot project, started in 1984, was designed to test the use of superheated steam plus carbon dioxide and a clay stabilization additive for recovery of bitumen from the Cold Lake Clearwater formation. Operations in two patterns and in the special test wells will extend into 1990 and a third major expansion is being planned. The AOSTRA-BP Marguerite Lake Pilot Project, started in 1978, is continuing operations. AOSTRA participated in the first phase of the project but is not directly participating in the current expansion phase. The AOSTRA-Husky Kearl Lake Pilot Project is continuing steam drive test operations. The former partners in the operations, Canterra Energy Ltd. and Tenneco Energy Ltd., have been replaced by Husky Oil Operations Ltd. and Esso Resources Canada Ltd. as participants. New agreements will extend operations into 1990 and beyond. The AOSTRA-Shell Peace River Pilot Project has resulted in the operation of a demonstration facility by Shell with a capacity of 1600 m3 per day using both the pilot project technology and existing pilot plant facilities. A multi company task force under AOSTRA's direction is examining the application of this technology to other leases in the Peace River deposits. Field operations at the AOSTRA/Unocal Buffalo Creek and McLean Pilot Projects on carbonates have been suspended until an analysis of all pilot data can be finalized. This analysis is expected to be completed in 1989.

To assist all in situ project evaluations AOSTRA has developed an extensive Data Base System (ADBS II) and an Economic Analysis model.

The Underground Test Facility (UTF) project initiated by AOSTRA in 1982, and subsequently joined by six industry majors and the CANMET division of the Federal Government has progressed strikingly during the past year. Field results have exceeded all forecasts and in some instances by remarkable margins. Development work can now be directed towards the optimum application of such processes in large scale operations. This project is an enormous success and has captured international interest.

Both the Heavy Oil Recovery Program and the Enhanced Recovery Programs in partnership with many companies have progressed significantly with accelerated AOSTRA priority. Wet combustion processes, modified non-thermal gas drive processes, hot water flood projects, steam flood projects and anti-water coning programs have been tested to improve heavy oil recovery. Eleven active programs with private sector companies have been in progress on "Enhanced Oil Recovery". These included short and long radius horizontal well testing, caustic polymer flood testing, carbon dioxide flood testing, nitrogen injection tests, and wet combustion testing.

During the past year significant developments have resulted in regards to the AOSTRA Taciuk Process. UMATAC has been assigned an exclusive license for applying this process for waste treatment applications and has begun construction of the first commercial portable treatment plant. It is designed to treat oily soils and sludges at a feed rate of 10 tons/hr. It will be used for cleaning sites in both Canada and the U.S.A. and will also be tested for waste treatment. A demonstration commercial facility using the AOSTRA Taciuk Process to produce oil from shales is being pursued in Australia. Discussions are ongoing in using the AOSTRA Taciuk Process on oil sands.

AOSTRA is continuing study and review on an on-going basis of a number of alternative mining and extraction methods such as the Solv-Ex Process, and the SESA Process. Jointly with the OSLO group, AOSTRA is funding and developing the Cold Water Extraction Process and the Bore-Hole Mining Process. Work is progressing on various approaches to solving the tailings pond sludge problem.

In the Upgrading Program a major test on Athabasca bitumen was successfully completed at the VEBA OEL Pilot facility in West Germany. The series of successful VEBA Combi-Cracking tests provides an excellent design database for upgrading in Alberta. Coal-Heavy Oil Coprocessing Studies have been initiated with several private companies and the Alberta Office of Coal Research and Technology.

Environmental activities have been given the highest priority and Environmental 'Audits have been initiated to ensure that established guidelines are being followed. Audits of four in situ projects were completed and two audit projects are in progress. The produced water recycling program was expanded. A separate section on the Environmental Activities is highlighted in this annual report.

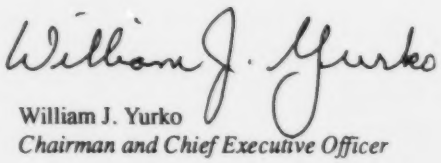
Several major initiatives were undertaken in AOSTRA's continuing effort to make foreign agencies aware of Canadian technology and services. The highlight was the hosting in Edmonton of the 4th UNITAR/UNDP International Conference of Heavy Crude and Tar Sands. Delegates from 36 countries presented more than 200 technical papers making this one of the most comprehensive conferences ever held on this subject. In addition, AOSTRA has maintained liaison and renewed or signed new Memorandums of Understanding and Cooperation with agencies from 15 countries.

Our institutional programs with the Alberta Research Council, Universities across Canada, the Saskatchewan Research Council and several private research organizations has continued at record levels.

The AOSTRA Library and Information Services and the AOSTRA Technology Transfer and Commercialization programs continued at accelerated levels.

Mr. Minister, we welcome your direction and involvement in accomplishing the AOSTRA Mandate prescribed in the legislation. The Alberta Oil Sands are one of Alberta's major resources and the new technologies being developed through the initiatives of AOSTRA, will substantiate a healthy and dynamic economic future for Alberta. AOSTRA's ability to achieve the results it has, is to a large measure, due to the dedication and efforts rendered by our employees. On behalf of the Board, I wish to extend my sincere appreciation for their continued good work.

Respectfully submitted,



William J. Yurko
Chairman and Chief Executive Officer

The Hon. Rick Orman and Members of the Authority
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Seated: W.J. Yurko, The Hon. Rick Orman, G. Shrake

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Report of Activities

1 In Situ Oil Sands Recovery Program

1.1 AOSTRA-AMOCO Gregoire Lake Pilot Project

A new in situ pilot was initiated in 1984 by AOSTRA, Amoco Canada Petroleum Limited and Petro-Canada Exploration Ltd. on a site approximately 15 km northwest of the former Block 1 pilot. The pilot consists of a four-spot pattern of injection, production and observation wells. Operations using steam and steam combined with additives commenced in late 1986 and have been extended to continue through 1989. The injection of a surfactant foam with steam was started in 1988 to test for improved oil production rates and recovery. Tracking of the initial heat front movement in the reservoir with the application of 3-D seismic monitoring techniques is a unique feature of the project.

1.2 AOSTRA-BOW VALLEY-COLD LAKE Pilot Project

With AOSTRA and Cold Lake Heavy Oil Ltd. as participants, Bow Valley initially operated a pilot in the Cold Lake area of northeastern Alberta in an inverted seven-spot pattern. The project which was started in 1984 was designed to test the use of superheated steam plus carbon dioxide and a clay stabilization additive for recovery of bitumen from the Cold Lake Clearwater formation. Preliminary laboratory and field studies lead to the development and application of a modified recovery process in the pilot project.

Based upon encouraging results from the first pattern, a second inverted seven-spot pattern on larger spacing plus two special test wells were drilled in 1986. Operations in both patterns and the special test wells have continued and are expected to extend into 1990. Preliminary planning is being conducted for a third major expansion of the project in the fall of 1989.

1.3 AOSTRA-BP Marguerite Lake Pilot Project

The Marguerite Lake Pilot Project was designed to test steam stimulation followed by wet combustion in the Clearwater sand formation of the Cold Lake oil sands deposit. BP Exploration Canada Limited operated the project with AOSTRA, Dome Petroleum (now Amoco) and PanCanadian Petroleum Limited as participants.

The project was started in 1978 and completed an initial steam stimulation phase and simultaneous combustion testing with air in special test wells. The decision to use oxygen instead of air for the combustion phase was made based upon feasibility studies conducted after the initial test phase. Five wells in the main pattern were converted to oxygen injection. Encouraging results were encountered with oxygen injection and related production operations continuing into 1987. The first phase of the project was completed on March 31, 1987 and an extension phase in which AOSTRA is not participating is being conducted by BP. A summary report on the first phase of the project is in preparation.

The Wolf Lake project which surrounds the pilot area started production in April, 1985 based on steam recovery technology developed at the Marguerite Lake pilot. BP is planning the use of oxygen combustion technology in the Wolf Lake operation.

1.4 AOSTRA-HUSKY Kearl Lake Pilot Project

Operated by Husky Oil Operations Ltd. (formerly Canterra Energy Ltd.), with AOSTRA and Esso Resources Canada Ltd. as participants, the Kearl Lake pilot project is located 77 km northeast of Fort McMurray near the location of the OSLO project. A steam drive process is being tested in the McMurray oil sands which are located at a depth of 150 m in this area. The sands have a thickness of about 43 m.

Two patterns are located in the project. An inverted seven-spot with seven injectors and six producers makes up the "A" pattern which was first tested starting in 1981. Based upon information from the "A" pattern, the "B" pattern which initially consisted of an inverted nine-spot pattern was designed and placed in operation in 1985. In 1987 the "B" pattern was expanded with the addition of two adjacent inverted five-spot patterns and observation wells adjoining the existing nine-spot pattern. Special fracturing techniques were applied in the two new patterns and steam additives were also tested in 1987 to improve recovery operations.

During 1988, operations continued in the "B" pattern and the "A" pattern was shut in. In early 1989, preparations were being made for the injection of gas adjacent to the "B" pattern wells to further improve recovery. Operations will continue through 1989.

1.5 AOSTRA-SHELL Peace River Pilot Project

The Peace River pilot project is located 30 km northeast of the town of Peace River and was operated by Shell Canada Resources Limited with Shell Explorer Limited, AOSTRA and Amoco Canada Petroleum Ltd. as participants. The project was designed as a prototype installation to test a modified steam drive recovery process in the Peace River oil sands which are 27 m thick and located at a depth of 550

m. Successful testing of a recovery technology based on cyclic steam pressurization and modified drive utilizing a 3 m bottom interval of high water saturation has been demonstrated. Steam stimulation through the first, second and third pressurization production cycles has produced approximately 45% of the original oil in place. The fourth pressurization/ production cycle began in 1988. In 1985, direct participation in the project was terminated by AOSTRA and Amoco.

A demonstration project with a capacity of 1600 m3/d has been constructed using the project technology and the existing pilot facilities. AOSTRA continues to receive data from the commercial project.

1.6 AOSTRA-UNOCAL Buffalo Creek and McLean Pilot Projects

Unocal Canada Limited with AOSTRA and Mobil Oil Canada Ltd. (formerly Canadian Superior Oil Limited) as participants, operate the Buffalo Creek and McLean pilot projects which are located approximately 100 km west of Fort McMurray. Tests in the Grosmont 2 and 3 Devonian carbonate formations have been conducted since 1977 to examine the suitability of steam stimulation, steam drive and wet combustion for bitumen recovery.

The McLean pilot test was conducted in a five-spot pattern and completed in 1983. A geological anomaly within the pilot area was indicated by the initial test results. Two additional wells were drilled in 1984 maintaining the original pilot concept and operations continued through 1985. Cyclic steam operations were initiated in two new production wells offsetting the McLean pattern in 1985. These wells were operated through 1986. In 1986, a special test program to investigate the relationships of geology to well operation in the McLean pilot was conducted. Due to mixed results of the 1986 field program, the field operations were suspended until an analysis of all pilot data could be finalized. The analysis continued through 1988 and is expected to be completed in 1989.

1.7 Data Base Management System

The AOSTRA Data Base System (ADBS II) provides entry, storage, reporting and retrieval of data collected by in situ projects. The system is used by project operators, project participants and AOSTRA internally. At the end of 1988, over 72 years of project data were resident within ADBS II, representing the detailed operations of 13 projects. Additional data from several projects is archived on tape, and may be used to create on-line databases within ADBS II in future.

The ADBS II uses a relational data base management system and is maintained on a mini computer located at AOSTRA's Calgary office. Authorized users can access the system in "time-share" mode to access data from projects in which they are participants. In addition, the ADBS II software has been installed and licensed on computers located in the offices of project participants.

Features of ADBS II include use of menus to simplify entry of commands, fast response time to large volume data searches, standard query language for data manipulation, and a comprehensive report package customized for each project. The system is cost effective and "user friendly". AOSTRA Computer Service staff provide ongoing technical support and enhancements to ADBS II.

AOSTRA welcomes inquiries from Industry regarding the licensing of ADBS II for in situ projects.

1.8 Economic Analysis

AOSTRA has developed an economic model for evaluating the commercial potential of new and existing in situ production projects. The model is now available for use on a microcomputer. The model contains a cost data base that will be updated as appropriate. The model has been used by AOSTRA to evaluate the commercial potential of pilot project expansions.

A study of the commercial potential of various projects and recovery processes was completed by the Canadian Economic Research Institute in 1988. The results of the study compared favorably with those generated using the AOSTRA model.

2 Underground Test Facility (UTF)

The Underground Test Facility (UTF) project was initiated by AOSTRA in 1982 with a series of design studies employing mine access to provide for effective testing of horizontal well in situ recovery processes. These studies led to a commitment to the construction of the UTF in 1984.

An industry steering committee, with representatives from sixteen firms interested in the UTF prospects, worked with AOSTRA during 1985 in a further major study to confirm project feasibility and identify a preferred priority of processes for field testing. During this period, work continued on the mine construction and on the development of a custom drilling rig designed to place long horizontal wells from the underground tunnel system.

The steering committee studies indicated good potential for the project,

but industry conditions at the time could not support immediate participation in a major heavy oil pilot. In early 1986, AOSTRA made a further commitment to limited Phase A testing of the preferred candidate, the steam assisted gravity drainage (SAGD) process. By the end of that year, the mine access facilities were complete and the custom drilling rig had been fabricated, field tested and reassembled down the mine ready for drilling of the test wells.

1987 saw the successful completion of the organizational and developmental activities leading up to the in situ process testing. Six industry majors and the CANMET division of the Federal Government became participants in the Phase A program. Enhanced geotechnical work and a separate test of Chevron's proprietary HASDrive process were added to the program. Difficult, but successful, underground drilling tests resulted in the placing of eight horizontal wells, with significant advances in the technology. By November 1987, all facilities were complete, including the additional HASDrive wells and equipment, and both process tests were into start-up.

In this past fiscal year, the project has achieved considerable success in both process programs. Field results have exceeded forecast, in some instances by remarkable margins. The effectiveness of gravity drainage processes in Athabasca has been clearly indicated; development work can now be directed towards the optimum application of such processes in larger scale operations.

For Fiscal 1989, the UTF site operations will carry on at the Phase A level to provide further insight into "mature" stages of the processes. Coincident with this field program, discussions will continue with the industry participants regarding an expanded program to test commercial length wells. Results to date fully warrant the next stage of development. It is hoped that general industry conditions will warrant an active pace.

3 Heavy Oil Recovery Program

3.1 AOSTRA-ALBERTA ENERGY Suffield Heavy Oil Pilot Project

Alberta Energy Company Limited (AEC) with AOSTRA, Amoco Canada Petroleum Ltd. (formerly Dome Petroleum Limited) and Westcoast Petroleum Limited as participants operated the Suffield Heavy Oil Project which is located in the glauconite sandstone under the Suffield Military Block in southeastern Alberta. The reservoir is 19.5 m thick and contains heavy oil underlain by water. The wet combustion process was being tested in an inverted five-spot pattern. The combustion operations was suspended at the end of 1986 in order to test an alternate recovery process even though pilot production was significantly greater than would be expected by primary recovery alone.

Following the addition of an off-set production well, a single well gas injection test was conducted during 1986 in conjunction with the combustion recovery operations. During 1987 and 1988 AEC, AOSTRA and Westcoast Petroleum conducted field tests of a modified non-thermal gas drive process in an inverted seven-spot pattern and a number of special single well tests at locations offsetting the original combustion test pattern. Testing of the process was completed in 1988.
In 1989, a hot water flood project was initiated in the field in an inverted four-spot pattern. Testing of the hot water flood will continue throughout 1989.

3.2 AOSTRA-NORCEN Bodo Field Pilot

AOSTRA, Norcen Energy Resources Limited, Esso Canada Resources (formerly Texaco Canada Resources), Murphy Oil Company Limited and Canadian Occidental Petroleum Limited are conducting a steam flood project in the Bodo field in east central Alberta for comparison to an earlier combustion project conducted in the pool. The original combustion pilot was operated by Norcen until 1984. A nine-spot steam pilot similar in configuration to the combustion pattern was constructed offsetting the combustion pattern. Operation of the steam pilot began in 1985. Three cycles of steam injection into the wells have been completed with encouraging results. The fourth cycle of steam injection is underway and expected to be completed by mid-1989.

4 Enhanced Recovery Program

4.1 AOSTRA-AMOCO Cessford Caustic Polymer Flood

Single well tracer test results were acquired by AOSTRA from Hudson's Bay Oil and Gas Company Limited (now Amoco Canada Petroleum Limited) in 1981 for earlier tests conducted in the Cessford Basal Colorado "A" Pool which is approximately 180 km east of Calgary. The test results indicated that single well tracer tests were effective for measuring residual oil saturation before and after caustic flooding. Hudson's Bay conducted further laboratory tests that indicated oil recovery could be

further improved with the addition of polymer to the caustic flood.

In 1986, AOSTRA agreed to participate in the field pilot testing of caustic-polymer injection. The project is now operated by Amoco Canada Petroleum Ltd. with AOSTRA and Esso Resources Canada Limited as participants. The ongoing tests are expected to continue through 1989. The incremental gross costs of the caustic polymer tests are estimated to be $4.9 million.

4.2 AOSTRA Anti-Water Coning Program

AOSTRA has initiated a study of methods of preventing water coning, particularly in heavy oil reservoirs underlain by water which are common in eastern Alberta. Several methods of anti-coning are being investigated, including the use of special additives and the use of bacteria. Numerical simulation has been undertaken to match the performance of a field test using coning and anti-coning results. Laboratory work has been initiated to evaluate the effectiveness of bacteria in anti-water coning tests. Preliminary results have been encouraging and the results of research should lead to field trials.

4.3 AOSTRA-BUMPER Twining Pool Horizontal Well Project

AOSTRA, Bumper Development Corporation Ltd. and Enron Oil Canada Ltd. participated in the drilling of a short radius horizontal drain hole in the Pekisko Rundle A formation in the Twining field which is located approximately 90 km northeast of Calgary. Bumper was the operator for the project which consisted of re-completing an existing well in the Twining pool by drilling a single horizontal drain hole from the cased well. Mechanical difficulties were encountered which precluded the comparison of productivity of vertical and horizontal wells in the Pekisko formation.

4.4 AOSTRA-CANADIAN HUNTER Ethel Lake "BHL" Pool Horizontal Well Project

Canadian Hunter Exploration Ltd., with AOSTRA as a participant, drilled a long radius horizontal well into the Ethel Lake BHL Pool in 1988. The purpose of the test was to assess the commercial viability of exploiting low permeability oil bearing carbonate reef reservoirs with horizontal wells where vertical wells have proven non-commercial. The results of the drilling program are currently being assessed.

4.5 AOSTRA CO_2 Flood Technology Program

In 1988, AOSTRA initiated a study of the potential application of CO_2 flooding in Alberta reservoirs. The results of the two CO_2 projects in Alberta in which AOSTRA participates were reviewed to establish screening criteria for identifying additional CO_2 flood candidates. Screening of all of Alberta's conventional oil pools was conducted and a final report was issued which identifies and ranks the best candidate pools for miscible and immiscible CO_2 flooding.

4.6 AOSTRA-D.B. ROBINSON Industry Slim Tube Study

A cooperative industry-supported research program is operated by AOSTRA to investigate the use of slim tubes to evaluate conditions of miscibility in miscible floods. The project is financially and technically supported by ten industrial companies and AOSTRA. D.B. Robinson and Associates Ltd. is the contractor for the project.

The objective of the project is to demonstrate the feasibility of collecting and analyzing small samples of flowing fluid in a slim tube, particularly in the transition zone between the solvent and the oil. Equipment was designed and fabricated for this purpose and tested in 1988. Slim tube tests are now being conducted with the equipment.

4.7 AOSTRA-GULF Fenn-Big Valley "D-3B" Nitrogen Injection Project

Gulf Canada Resources Ltd. and AOSTRA participate in a nitrogen injection project in the Fenn-Big Valley "D-3B" pool located approximately 80 km east of Red Deer. Gulf operates the project which was started in 1987. Nitrogen was injected into the small Devonian reef reservoir to determine if the recovery of oil, natural gas liquids, sulphur and gas could be improved by the maintenance of reservoir pressure and the stabilization of fluid interfaces. The project has been extended to test the effectiveness of nitrogen foam in further enhancing recovery.

4.8 AOSTRA-HUSKY Asphaltene Solids Precipitation Project

A laboratory study of the precipitation of asphaltenes in selected light oils when contacted by hydrocarbon solvents is being conducted in a jointly supported research program undertaken by Husky Oil Operations Ltd. (formerly Canterra Energy Limited) and AOSTRA. The formulation of a mathematical model using an equation of state and data obtained from asphaltene solubility tests to predict the

deposition of asphaltenes under variable pressure and temperature conditions is an important goal of the study. Husky is the operator of the project with Hycal Energy Research Laboratories as the contractor. The first phase of the study was completed in 1987 at a cost of $198,500.

In order to extend the applicability of the equation of state model that was developed in the first phase of the study to a wider range of oil types, a second phase of the study was initiated in 1988. The second phase is now being conducted at an estimated cost of $111,980.

4.9 AOSTRA-MUNGAN PETROLEUM Enhanced Oil Recovery Book

AOSTRA is supporting the publication of a book on enhanced oil recovery by chemical and miscible methods. The book is being written by Dr. Necmettin (Nic) Mungan of Mungan Petroleum Consultants Limited. The book will include a state of the art description of recovery methods, such as polymer, alkaline, surfactant, and miscible flooding. The book will also contain chapters on residual oil saturation, wettability, interfacial tension and pilot testing in the field.

4.10 AOSTRA-PANCANADIAN Countess "B" Combustion Pilot

A wet combustion recovery process is being evaluated in the waterflooded Countess Upper Mannville "B" pool by PanCanadian Petroleum Limited and LL&E Canada Limited who are partners in the Countess "B" pool. The project which is located near Brooks, Alberta, is being operated by PanCanadian. The pilot which was initiated in 1982 continued to operate through 1988 with encouraging results.

A research program is being funded by AOSTRA to support the pilot activities. The supporting research program included combustion tube tests, geological studies, emulsion treating studies, corrosion studies, combustion front mapping, a post combustion core well, numerical simulation modelling, a production sampling well and core flow tests for process evaluation. The supporting research program will continue through 1989.

4.11 AOSTRA-PFIZER Profile Modification Study

AOSTRA and Pfizer Canada Inc. are participating in a research program to test the modification of injection profiles in injection wells in waterfloods by the injection of a gelant slug into highly permeable thief zones. The goal of the project is to demonstrate with field trials in suitable fields the effect of improved injection profiles on volumetric sweep and ultimate recovery. Negotiations with field operators to identify suitable field candidates and to conduct the tests have been initiated and field testing is expected to proceed through 1989.

4.12 AOSTRA-VIKOR Joffre Viking CO_2 Miscible Flood

The Joffre Viking CO_2 miscible flood is the first miscible CO_2 flood to be conducted in Canada. It is located in a previously waterflooded and abandoned segment of the Joffre Viking (lower Cretaceous) sandstone reservoir. Vikor Resources Limited operates the project on behalf of AOSTRA and the Unit participants in the project. The project is located in central Alberta approximately 20 km northeast of Red Deer.

CO_2 injection commenced during 1984 in the initial pilot which consisted of two five-spot patterns each 65 ha in area. The pilot tested the ability of a CO_2 miscible flood to recover tertiary oil from a 3 m thick previously waterflooded reservoir containing light gravity oil. CO_2 injection alternating with water injection (WAG Process) for mobility control continued until October, 1986. Water injection was then continued into the patterns. A third well was converted to CO_2 injection in 1986 to improve oil recovery near the edge of the reservoir.

Oil production response to CO_2 injection was evident in 1984. The encouraging results of the pilot resulted in a commercial expansion consisting of eight wells in an area offsetting the pilot in 1985. A second pilot expansion was undertaken in 1988 with the development of another pattern near the original pilot area. In addition a mobility control tests using a foam surfactant test was initiated in 1988 in the original pilot area.

4.13 AOSTRA-ULSTER PETROLEUMS Retlaw Upper Mannville "B" Immiscible CO_2 Project

Ulster Petroleums Limited (formerly Canadian Westgrowth Limited) is the operator of the Retlaw Upper Mannville "B" Unit Immiscible CO_2 Project. This is the first immiscible CO_2 project to be conducted in Canada. The objective of the project, which is located near Lethbridge, is to evaluate the performance of a CO_2 immiscible flood in a water sensitive medium gravity oil reservoir. The injection of CO_2 commenced in 1983 and will continue through 1989.

The operating data on the project is being acquired by AOSTRA for analysis of the performance of the project.

5 Engineering & Technology Development

5.1 Alpha Engineering — Cyclic Steam Analytical Model

A cyclic steam stimulation analytical model for a vertically fractured reservoir was developed by Alpha Engineering. Development of refinements to the model for vertically fractured reservoirs and a model for horizontal fractures is in progress. AOSTRA is one of six participants each committed to $6,250 for the project.

5.2 Centre for Frontier Engineering Research

AOSTRA has continued to fund and actively participate on steering committees for CFER programs. Excellent progress in the areas of casing-joint makeup measurement, finite element analysis of casing/tubing joints, analyses of rod wear problems, evaluation of K-55 grade casing material for thermal well casing and finite element analyses of casing-formation interactions is being made. AOSTRA expended $25,000 in the 1988/89 fiscal year in support of this effort.

5.3 Computer Modelling Group — Thermal Well Simulator (THEWS)

The Thermal Wellbore Simulator (THEWS) Program jointly conducted by CMG and AOSTRA, is producing a fully transient finite element wellbore heatloss model capable of handling very complex boundary conditions. Testing of the "steam" version by Shell, BP, Husky and AOSTRA has been successful. The "production" version is in the final stage of development and the coupling of THEWS with CMG's STARS reservoir simulator is in progress.

5.4 FEKETE — Thermal Well Test Package

AOSTRA entered into an agreement with Fekete Associates Inc. in May, 1988 to develop a thermal well testing software package. The package, consisting of current well testing theories, was developed for an IBM PC computer and submitted to AOSTRA for testing prior to its release for use by industry. Total AOSTRA financial support to the project has been $80,000.

5.5 In Situ Engineering Support Program

The In Situ Engineering support program was established in 1987 to conduct engineering studies to develop our understanding of various new technologies and support field application, marketing and technology development efforts. Specific technologies for which studies have been undertaken in the 1988/89 fiscal year include:

- Additive Anti-Water Coning — developing an understanding of the technology prior to selecting additional reservoirs for application.
- Bacterial Anti-Water Coning — conducted laboratory tests under field conditions in preparation for test site selection.
- Aquathermolysis — experiments to optimize process prior to selecting field.
- CO_2 Miscible and Immiscible Flooding and their future applications have been assessed.
- Peace River Recovery Mechanism — the application of technology developed at the AOSTRA/Shell/Amoco PRISP pilot to other areas of the Peace River Deposit is being considered. Efforts included developing and presenting a proposal to industry and the formation of a task force to pursue further application of this technology.

Expenditures in this program total approximately $193,000.

5.6 In Situ Site Studies Program

A number of geological studies were conducted to support technology development and application in the Grosmont, Peace River and Wabasca deposits and in the Lindbergh area. AOSTRA expenditures for this program in the 1988/89 fiscal year total $32,400.

5.7 Liao He Contract

AOSTRA staff provided contract engineering to the Liao He Petroleum Exploration Bureau of China on its proposed Liao He steam pilot project. The contract covered the design, evaluation and recommendation of public domain methods to determine downhole steam quality, fluid injection/production profiles and near-wellbore fluid saturations. The project has been successfully concluded and was valued at $24,500.

5.8 MAURER — Horizontal Well Technology

AOSTRA joined a consortium consisting of more than 50 companies from 13 countries in support of a project being conducted by Maurer Engineering Inc. of Houston, Texas to develop and evaluate horizontal drilling completion and production technology. The 24 month project initiated in March, 1988 will cost a total of $1,750,000 with AOSTRA's share being $35,000.

5.9 Simons Consulting Services Coning Project

AOSTRA entered into a letter of intent in September, 1988 with Simons Consulting Services Ltd. to study novel methods of preventing water coning into oil production wells. The first phase of the project, physical and numerical simulation studies, has been completed and a field test is being considered. AOSTRA expenditures in the 1988/89 fiscal year totaled approximately $64,000.

5.10 SIMTECH — Geomechanics Technology

AOSTRA, with seven other companies, have supported geomechanics technology being developed by Simtech Consulting Services Ltd. since 1985. Three numerical simulators have been developed to study in situ stresses in oil sand for predicting the effect of hydraulic fracturing and deformation of oil sands during in situ thermal recovery. AOSTRA expenditures on this project have totaled $35,000. Phase II consisting of developing the physics for the thermal models and coupling the hydraulic fracture models with a reservoir simulator was undertaken in 1988 with an additional AOSTRA commitment of $10,900.

6 Produced Water Recycling Program

Over the past ten years AOSTRA, both alone and in partnership with industry, has been investigating methods by which waters co-produced with bitumen or heavy oil from in situ recovery operations may be treated and reused as boiler feedwater. The ability to recycle produced water will minimize the demand for fresh make-up water and reduce problems associated with the disposal of untreated waters.

Development, testing and evaluation of water treatment technologies is a continuing activity because of the wide variability in the quality of produced waters and the continuing search for minimum cost treatment methods.

Produced waters in Alberta have been roughly classified according to total dissolved solids (TDS) levels. Waters produced from the Peace River deposit typically have low TDS (less than 8,000 mg/l) and do not require treatment for TDS reduction. However, the hardness and silica levels are sufficiently high that some form of treatment is required.

Lindbergh area produced waters have relatively low silica levels, but the TDS levels are very high (17,000 mg/l and greater). Therefore a water treatment scheme must focus on the reduction of TDS to a level acceptable for steam generation.

A third type of water is that with a moderate level of TDS (8,000–17,000 mg/l) and a moderate level of silica. Cold Lake area produced water falls into this category.

6.1 Peace River Produced Water Treatment Pilot Project

AOSTRA has participated with Shell Canada Limited in a produced water treatment pilot at Shell's Peace River in situ oil sands operation at a total project cost of $2.5 million of which 35 per cent was funded by AOSTRA. The pilot incorporates treatment facilities for the removal of oil and hardness but does not remove silica from the produced water. Also included in the pilot is a small steam generator to determine the degree of fouling on boiler tubes due to silica scaling.

Construction of the pilot was completed in 1987 and since that time all test runs on the steam generator have been completed. The steam generator performance was tested at increasing levels of silica concentration. The presence of scale in the radiant tubes during the fourth run has resulted in a reduction in the level of silica recommended for extended operation. A six-month run of the steam generator began in April, 1988 and evaluation of the long-term operating characteristics of the system is complete.

A series of tests on the operation of the ion exchange units for hardness removal has determined effective regenerator operation at target levels and frequency. Deliberate oil fouling of the ion exchange resins was conducted to measure the extent of the reduction in capacity of the ion exchange units.

The project is considered successful and it will assist in setting new operating parameters for Shell's commercial water treatment and steam generation facilities at the Peace River complex.

The final report was received in March, 1989. It will become part of AOSTRA's technology bank available for sale to other potential industry users.

6.2 Lindbergh Area Produced Water Treatment Project

The quality of the water produced with the heavy oil in an in situ recovery operation varies widely from one geological formation to another within Alberta. In order to treat the produced water in the Lindbergh area for reuse as feed water for steam generation, it is important to reduce the total dissolved solids (TDS). The existing technology for TDS removal is currently not economically feasible.

TDS removal can be achieved in processes such as electrodialysis, reverse osmosis, vapor compression evaporation and freeze desalination.

In 1986, AOSTRA, Environment Canada, Amoco Canada Petroleum Company Ltd., Dome Petroleum Limited, Murphy Oil Company Ltd., PanCanadian Petroleum Limited and Westmin Resources Limited initiated the first phase of a project to test treatment processes for high TDS produced waters.

In Phase I of this project the efficiency and operating characteristics of a vapor compression evaporator (VCE) for TDS removal were tested. Pilot testing of the VCE at Murphy's Lindbergh Thermal Project commenced in 1987 and was completed in 1988. Results of the pilot test show that TDS removal by evaporation is technically achievable. However, pretreatment of the VCE feed is necessary to stabilize the characteristics of the water. This may render the treatment more expensive than originally anticipated.

Phase I of the project was carried out at a total cost of $875,000 with AOSTRA contributing $375,000 towards the cost of Phase I.

The VCE process evaluated in Phase I is technically the most advanced of all the TDS removal processes. Electrodialysis, while not proven to the same degree as VCE, offers potential cost advantages.

Accordingly, in 1988, the Phase I participants, with the exception of Dome Petroleum Limited, approved a second phase of the project to test the electrodialysis process for TDS removal.

Part 1 of Phase II will include laboratory testing of electrodialysis coupled with ultrafiltration and microfiltration field tests at a total cost of $160,000.

If the process arrangement proves successful, then the participants may elect to proceed with field testing of a continuous flow electrodialysis pilot.

6.3 Thermal Lime Softening Process Development

Presently, the only commercially available technology to treat Cold Lake produced water for reduction of hardness and silica is the Hot Lime Softening process. The disadvantages of Hot Lime Softening are its relatively high capital and operating costs and production of a lime sludge which requires disposal in an environmentally acceptable fashion.

Esso Resources Canada Limited are developing a Thermal Softening process to reduce temporary hardness but it appears that it may not be able to reduce permanent hardness and silica.

In 1988, AOSTRA joined Monenco Consultants Limited, Energy Mines and Resources Canada (CANMET) and Supply and Services Canada to investigate and test a Thermal Lime Softening Process. This process, proposed by Monenco, incorporates the best features of the Hot Lime Softening and Thermal Softening processes to remove hardness, silica, total organic carbon and metals. Phase I of the project involves the construction of a special bench scale apparatus and conducting batch scale tests of the Process. Preliminary results are encouraging. AOSTRA and Supply and Services Canada are funding this Phase I at a total cost of $115,000 on a 50:50 basis.

Should the favorable preliminary results of Phase I be confirmed the participants may elect to proceed with the construction and operation of a larger scale, continuous flow pilot plant in the laboratory prior to conducting large scale field pilot tests.

7 Surface Mining/ Extraction Program

7.1 AOSTRA Taciuk Direct Thermal Processor

The AOSTRA Taciuk Process, which is owned by AOSTRA, has been developed in conjunction with UMATAC Industrial Processes Division of UMA Engineering Ltd. for the simultaneous extraction and primary upgrading of bitumen from mined oil sands. The Process is a thermal retorting process which accepts run-of-mine oil sands feed and produces cracked petroleum distillates; dry, oil-free tailings; off-gas, and process waters. The principal process operations occur in a single, horizontal rotating vessel, called the Processor, which together with auxiliary equipment to recover products and effluent wastes make up the AOSTRA Taciuk Process System.

The development of this technology, which has proceeded without interruption since 1977, has been funded entirely by AOSTRA at a cumulative cost of approximately $18 million.

The AOSTRA-owned 105 tonnes/day continuous flow pilot plant in Calgary has processed successfully over 12,000 tonnes of oil sands and other candidate feeds. This operating experience has confirmed the operational and performance characteristics of the Process and has led to improvements in mechanical design and the development of scale-up criteria.

The AOSTRA Taciuk Process System is ready for field demonstration in an oil sands application and AOSTRA continues to discuss the use of the Process for mined oil sands applications with lease holders and other potential

industrial users in an effort to attract industrial participation in a large scale field demonstration.

The two other applications of the AOSTRA Taciuk Process, the processing of oil shales and treatment of hydrocarbon bearing solid waste materials, continue to generate a substantial degree of interest.

As a result of favourable test results obtained from the processing of 1500 tonnes of oil shale from the Stuart Deposit of Queensland, Australia, in 1987, AOSTRA has entered into an agreement with Southern Pacific Petroleum NL (SPP) and Central Pacific Minerals NL (CPM) under which SPP/CPM may construct a 6000 tonne per stream day semi-commercial oil shale demonstration plant in Australia. Construction start is subject to SPP/CPM's ability to acquire suitable project financing.

In 1988, AOSTRA granted an exclusive license to UMATAC to use the AOSTRA Taciuk Process for the treatment of hydrocarbon bearing wastes and to grant sub-licenses for such purpose to third parties. UMATAC and Canonie Environmental Services Corp. of Porter, Indiana, have formed Soiltech Inc. a United States company which has been granted a sub-license by UMATAC to use the Process for waste treatment applications in the United States. UMATAC are presently constructing in Calgary a 240 ton per day transportable System for Soiltech at a cost of $4.5 million. This plant will be used by Soiltech to separate and recover polychlorinated biphenyls (PCB's) and associated oils from harbour sediments at Waukegan, Illinois. The recovered PCB's will then be destroyed by others. This plant is to be tested and commissioned in 1989 with commercial operations scheduled to commence in 1990.

A test program for treating heavy oil production wastes from the Lloydminster and Cold Lake areas of Alberta using the AOSTRA Taciuk Process was completed at the Calgary pilot plant early in 1988. This program was jointly funded by Environment Canada, Energy Mines and Resources Canada, Supply and Services Canada and AOSTRA. The program consisted of batch pyrolysis and combustion tests on a wide range of heavy oil production wastes followed by the processing of approximately 380 tonnes of heavy oil production waste materials in the 105 tonnes/day pilot plant. Analysis of test results indicated efficient recovery of the contained hydrocarbons and production of hydrocarbon-free spent solids which are environmentally acceptable for landfill. Information meetings to present the test results and economics of a commercial treating facility were conducted in 1988 for the benefit of government agencies, the oil industry and remedial action contractors at Edmonton, Ottawa, Calgary and Lloydminster. These information sessions proved to be effective.

7.2 OSLO (Other Six Leases Operation) Dredge Mining and Cold Water Extraction Development Project

AOSTRA and the OSLO Group have funded the first three years of a multi-year project, on a 50-50 basis, to test and evaluate the use of dredges to mine oil sands and to develop a compatible Cold Water Extraction Process. It is believed that this approach may significantly reduce the overall cost of bitumen production from mined oil sands.

The overall project is a phased five-year program which would cost approximately $31 million and which would culminate in a field demonstration of a semi-commercial sized dredge/extraction facility.

The first year (1987/1988) program, approved by AOSTRA and OSLO at a cost of $900,000, consisted of laboratory based testing of the Cold Water Extraction Process, design, construction and operation of a laboratory sized pilot dredge, oil sands slurry pumping and dispersion tests, and a feasibility study for field testing of the pilot dredge and the Cold Water Extraction Process.

The experimental results were very positive showing attractive bitumen recoveries in the laboratory extraction tests and physically illustrating the ability to extract bitumen from dredged oil sands in an integrated operation of the pilot plant in Calgary.

In Year 2 (1988/1989) of this project, testing continued with simulated dredge pond de-icing tests carried out at Esso Resources' test basin in Calgary; continuation of laboratory scale extraction tests; transportation, set-up and field testing of the integrated dredging, pipelining and extraction pilot plant at a location on lease #41 near Ft. McMurray and a detailed engineering study and preparation of final cost estimates for a 600 tonne/hour field demonstration facility. The Year 2 costs were $2.0 million of which AOSTRA has funded 50%.

The field testing on lease #41 proved very successful with measured bitumen recoveries in excess of the target.

OSLO and AOSTRA have approved a Year 3 (1989/1990) field testing program to be conducted on lease #41 at a total cost of $4.6 million in which dredging and cold water extraction of bitumen is to be demonstrated on a continuous basis. The Year 3 program also includes a study of methods for cleaning cold water froth. One element

of this study is a comparative evaluation of froth upgrading processes which are able to accept untreated cold water froth. One process to be evaluated is the AOSTRA Taciuk Process.

7.3 OSLO Borehole Mining and Cold Water Extraction Process

OSLO has been developing the technical features of a borehole hydraulic mining process to mine oil sands hydraulically by means of high pressure water jets operating in sub-surface chambers in an oil sands formation. This technique would be applicable to oil sands reserves located at depths between 300 and 800 feet and would incorporate the synergisms of hydraulic mining with the OSLO Cold Water Extraction Process currently being developed in conjunction with oil sands dredging. OSLO leases contain about 17 billion barrels of bitumen in this depth range which cannot be economically extracted by surface mining or in situ methods currently used successfully by industry.

AOSTRA to date has participated in Year 1 and is currently participating in Year 2 of a four-year OSLO program together with Energy Mines and Resources Canada (CANMET). Funding for Year 1 by AOSTRA was $247,500, (37 1/2% of $660,000). The Year 1 Program consisted of jetting tests in air and under water in both laboratory and field experiments, development of a new extendable arm jetting device and evaluation of special drilling tools and techniques. The encouraging lab and field jetting tests have led to continued technology development in Year 2.

AOSTRA's funding of the Year 2 program is $440,000 (50% of $880,000). The Year 2 program includes the purchase of a special borehole mining tool, further development of an extendable jetting arm and some field testing to be conducted on Lease 41 by OSLO.

7.4 Solvent Extraction-Spherical Agglomeration (SESA) Process

In 1988, AOSTRA and the National Research Council (NRC) entered into an agreement to participate with Terra Energy Ltd. in the preparation of engineering designs and cost estimates for a demonstration plant to test the SESA process for the extraction of bitumen from mined Athabasca oil sands.

The SESA process involves contacting mined oil sands with carefully controlled small amounts of water and a naphtha solvent in a rotating drum. The naphtha solvent extracts the bitumen while the water facilitates the agglomeration of the fine clay minerals with the sand particles. In a series of solids-liquid separating steps, bitumen diluted with solvent naphtha and a tailings of agglomerated solids wetted with the naphtha solvent are produced. The solvent is recovered from the bitumen by conventional refinery distillation and from the tailings by evaporation. The recovered solvent is recycled to the Process. The dried agglomerates can be transported by trucks or conveyors to the mined out pit for disposal. Terra Energy has been granted a license by Canadian Patents and Development Limited (CPDL) to develop and operate a SESA demonstration plant. The SESA solvent extraction process has been developed and piloted on a laboratory scale by NRC.

Phase I of the project will cost $1.0 million and is being funded on a 50-50 basis by AOSTRA and NRC. This phase consists of the preparation of engineering designs and capital and operating costs estimates for the construction and operation of a 10 tonne per hour demonstration plant and a technical and economic evaluation of the SESA process compared to the conventional hot water extraction process.

The preliminary process design, material and energy balances and cost estimates for the 10 tonne per hour demonstration plant are complete.

The engineering, cost estimates and economic studies comparing a commercial 30,000 BPCD mining project incorporating the SESA Process with a similar sized plant utilizing the existing hot water extraction process are also complete.

The engineering and comparative studies were carried out by Kilborn Energy Inc., a Canadian engineering and construction firm experienced in the operation of existing commercial mined oil sands projects. The final reports for this phase of the project are expected by mid-1989.

AOSTRA and NRC are currently evaluating the economic advantages of the SESA Process and, subject to appropriate economic incentives, may elect to continue with the next phase to conduct detail engineering and cost estimate for the construction and operation of a 10 tonne per hour demonstration plant to be located at a suitable site near Fort McMurray.

Terra Energy are pursuing with industry and other potential investors, the financing of the construction and operation of the proposed demonstration plant.

7.5 OSTEX Process — Improved Recovery of Naphtha and Bitumen from Hot Water Process Tailings

In early 1988, AOSTRA approved funding of $100,000 to evaluate the feasibility of recovering naphtha and bitumen from the tailings produced by dilution centrifuging of hot water extraction bitumen froth. By means of a patented hot gas induced flotation process, recoveries of 60% of the naphtha and 75% of the bitumen are predicted.

A batch type, bench scale apparatus has been constructed and tested in Calgary by M.G. Engineering Division of TZIPA Enterprises Ltd., the inventors of the OSTEX Process. Preliminary test results indicate that the recoveries are better than originally predicted. Testing is continuing and preliminary results are being evaluated by AOSTRA.

7.6 Syncrude/Suncor Bitumen Recovery from Tailings Pond Sludge

Acting on an initiative taken by the operators of the two commercial mined oil sands plants, AOSTRA is participating with Syncrude Canada Ltd. and Suncor Inc. in a study to evaluate the costs and benefits of five processes for recovering bitumen from hot water process tailings pond sludge. Initially a two-phase study is planned.

The percentage of the total bitumen contained in the oil sands feed to the Syncrude and Suncor plants which is discharged with the extraction process tailings is relatively small. However, after many years of operation, tens of millions of barrels of bitumen have accumulated in the sludge layers of the existing ponds.

Phase I of the study, which included definition of study parameters, establishing the physical and chemical characteristics of the bitumen to be recovered in its pond environment, quality objectives for the recovered bitumen, identification of potential recovery processes and the establishment of economic parameters, is complete. Requests for bids from engineering contractors to conduct the detail study have been issued. Phase I cost of $60,000 will be shared equally by the three participants.

Upon evaluation of the bid proposals, it is anticipated that the three parties will elect to participate in Phase II in which the successful engineering contractor will conduct the detailed process evaluation.

7.7 Syncrude Disposal of Tailing Pond Sludge in Mined Overburden Dumps

The objective of this program is to develop an economically viable method of absorbing tailings pond sludge in stable overburden dumps. Currently all of the sludge is stored in ponds in liquid form and, after settling, reaches about 30% solids content within about 5 years. Techniques to dewater the sludge by absorption into stable overburden dumps would significantly reduce the environmental impact of the existing tailings ponds.

Syncrude Canada Ltd., since 1982, has conducted related studies, into mining industry related practices, field overburden dredging tests and geotechnical testing all of which have provided useful background data to support the present project.

There are many millions of cubic meters of sludge in the existing tailings ponds of the two commercial mined oil sands plants and additional volumes are generated annually through the use of the hot water extraction process.

The results of laboratory and field tests to date indicate that it is technically feasible to absorb sludge in the Clearwater formation of the overburden and that stable overburden dumps can be created. The program of laboratory and field testing is continuing and the current phase is expected to be complete by year-end 1989. AOSTRA is participating with Syncrude on a 50:50 basis at a total project cost of $900,000 for Phase I of the program.

7.8 Solv-Ex Solvent/Water Extraction Process Evaluation

During 1986 and 1987 AOSTRA, Shell Canada Limited and Solv-Ex Corporation participated in a project to test the performance of the Solv-Ex Process for the extraction of bitumen from mined oil sands and to determine capital and operating costs for the construction and operation of a demonstration plant on Shell's surface mining lease in the Athabasca deposit.

The Solv-Ex Process is a development of the Solv-Ex Corporation of Albuquerque, New Mexico, and is essentially a solvent-assisted hot water extraction process. The feed oil sands is mixed with water and solvent in a staged counter-current process circuit. The process discharge streams are bitumen product and damp solids with the solvent and most of the process water being recovered for reuse.

The project consisted of two phases. Phase I, which cost $6 million, was funded by Shell and AOSTRA on a 50/50 basis and consisted of a test run program in a one tonne/hour pilot plant located in Albuquerque. The pilot plant testing was completed in 1987. Twelve hundred tonnes of oil sands feed material were shipped to Albuquerque

from Shell's lease near Ft. McMurray, Alberta. Final reports for the Phase I work have been received.

Phase II of this project consisted of the preparation of engineering designs and capital and operating cost estimates for a 1200 m3/d stand-alone bitumen production plant to serve as a semi-commercial demonstration of the Solv-Ex Process. The Phase II engineering and cost estimates were prepared by Fluor Canada. The total cost of Phase II was $1.2 million of which 25% was paid by AOSTRA and 75% by Shell Canada. The Phase II final report has been received.

AOSTRA completed its evaluation of the pilot plant test results and the economic viability of a semi-commercial demonstration plant in 1988. As a result of its evaluation, AOSTRA has concluded that the Solv-Ex Process requires further development and testing at the laboratory scale pilot before it would be ready for scale-up and semi-commercial field operations.

8 Upgrading Programs

8.1 VEBA Combi-Cracking (VCC) Test

The demonstration of improved upgrading technology continued in 1988/1989 with the completion of tests on the VEBA Combi-Cracking (VCC) Process on Athabasca bitumen. An earlier test on Cold Lake heavy oil was completed in 1986/87. The success of the Cold Lake test and a growing interest in upgrading Athabasca bitumen using VCC technology led to the second series of tests. These started with a seventeen day run on 235 m3 of Athabasca bitumen residuum which was successfully completed in January, 1988 on the VEBA OEL pilot plant in Gelsenkirchen, West Germany. To provide a complete design database on Athabasca feedstocks, further testing was undertaken on VEBA's smaller scale Process Demonstration Unit in June, 1988. AOSTRA provided $1.5 million, 60% of the costs of these tests; VEBA OEL absorbed the remaining 40% of the test costs.

The series of successful tests provides an excellent design data base and confidence that the VCC Process is ready for commercial application for heavy oil upgrading in Alberta. This was confirmed in early 1989 when VCC was selected as the upgrading process for the OSLO Project, the next major commercial oil sands project proposed for the Ft. McMurray area.

8.2 Coal/Heavy Oil Coprocessing

The processing together of coal and heavy oil may offer significant advantages over the separate but related processes of heavy oil upgrading and coal liquefaction. Coal is a much cheaper hydrocarbon than oil, but is more difficult to convert to liquid fuel products than heavy oil or bitumen. If coal is coprocessed with heavy oil in a hydrocracking reactor the advantages of lower cost feedstock may predominate. This is particularly true in Alberta where the feedstocks, sub-bituminous coal, heavy oil and natural gas are readily available and a market exists for the synthetic crude products.

AOSTRA together with the Alberta Office of Coal Research and Technology (AOCRT) and Canadian Occidental Petroleum Ltd. initiated in 1988 a joint government and industry project to study Coal/Heavy Oil Coprocessing. The objective of the project is to determine the relative merits and economics of coprocessing compared to heavy oil upgrading and to identify other related issues affecting its commercial development. In Phase I, the organizational phase, the participants include three government organizations, (AOSTRA, AOCRT, and Saskatchewan Energy and Mines) and seven companies, (Alberta Power, AMOCO Canada Petroleum Company Ltd., Canadian Occidental Petroleum Ltd., Gulf Canada Ltd., Husky Oil Operations Ltd., Shell Canada Ltd. and TransAlta Utilities Corp).

In Phase I a number of strategic issues related to coal heavy oil coprocessing have been screened. These include technology, feedstocks, (both coal and oil), potential plant locations, plant sizes and product qualities. The preliminary conclusion is that coprocessing is a promising alternative to future heavy oil upgrading projects.

A second phase is proposed for 1989/1990. This will define and screen the factors most affecting the commercial development of coprocessing of coal and heavy oil in Alberta.

8.3 Upgrading Residue Utilization Project

The utilization of residues (coke or pitch) produced by the upgrading of heavy oil can be very important to the economics and environmental impact of an upgrader. In 1988/1989 AOSTRA, the Federal department of Energy Mines and Resources and seven industrial participants continued a $260,000 test program on the combustion of upgrading residues.

Combustion tests were successfully completed on five different residues generated by the following upgrading processes; CANMET, DRB, EUREKA, H-OIL and VCC. Four of the residues were successfully fired as liquids. This

was a significant accomplishment because of the inherent difficulties in pumping, handling and atomizing these high viscosity, high ash liquids.

Three of the liquid residues were tested at Energy, Mines and Resources' Combustion and Carbonization Research Laboratory (CCRL) near Ottawa. The other liquid residue was tested in comparable equipment at Energy and Environmental Research Corporation's (EERC) facilities at Irvine, California. A check run was also made at EERC on one of the liquid residues tested at CCRL.

One of the residues, Eureka pitch, was successfully fired as a solid in the CCRL facilities. This required special testing, solids handling and grinding to prepare the material for combustion.

The tests demonstrated that upgrading residues can be successfully fired. The combustion and heat release was similar to conventional heavy fuel oil firing. A boiler test was also completed at CCRL on a typical liquid pitch. This test indicated that the residue properties, including high metals, sulphur and ash were potential problem areas relating to deposits and fouling. Further work in this area is planned for 1989/1990.

9 Environmental Activities

AOSTRA has always been conscious of the environmental consequences associated with the use of promising new technologies for the economic recovery and processing of oil sands bitumen and heavy crude oils. For the most part, environmental benefits derived from technology development programs undertaken previously by AOSTRA have been supplemental to the broader goals of enhanced economics, resource utilization and removal of technical roadblocks to resource development. Technology developments which provide supplemental environmental benefits are exemplified by AOSTRA projects dealing with

- new processes for the extraction of bitumen from mined oil sands such as solvent extraction and thermal retorting processes which generate dry or damp tailings and thus eliminate or greatly reduce the size of tailings ponds.
- high conversion bitumen upgrading processes which reduce the production of upgrader residue that must be disposed of or stockpiled.
- produced water treatment processes which permit water for steam generation for in situ recovery to be recycled thereby ensuring supplies of boiler feedwater while at the same time reducing the demand for fresh water and the amount of contaminated water sent to deep well disposal.
- the development of the AOSTRA Underground Test Facility to demonstrate the viability of shaft and tunnel access to bitumen reservoirs that are too deep for surface mining and too shallow for conventional in situ techniques involving high pressure steam injection. Surface disturbance is minimized as a consequence of the underground access to the reservoir.

While work is continuing in each of these areas, AOSTRA has recently become involved in a number of projects which directly focus on environmental concerns associated with the oil sands and heavy oil industries.

9.1 Clean-up and Reduction in Size of Tailings Ponds

The clean-up and reduction in the size of tailings ponds resulting from use of the Hot Water Process has been addressed in two ways. Unrecovered bitumen is present in the tailings that are rejected by current commercial processes for the extraction of bitumen from mined oil sands. AOSTRA is participating in a project to evaluate methods by which this bitumen may be recovered from the pond sludge created by the suspension of fine solids in the water phase. If the bitumen can be recovered efficiently and in sufficient quantity, it will provide a cleaner suspended solids layer and improved overall bitumen recoveries.

The occurrence of the sludge layer itself contributes to the ever increasing volume of material which must be retained in the tailings ponds since the fine solids settle very slowly or not at all. AOSTRA is participating in a project to examine a mechanism by which the sludge may be absorbed and dewatered in stable, trafficable overburden waste dumps. Successful implementation would improve the present waste management methods, minimize the volume of material retained in the ponds and minimize the consequences of leakage or failure of the tailings pond retention dykes.

9.2 The Treatment of Hydrocarbon Bearing Wastes

The use of the AOSTRA Taciuk Process for the treatment of hydrocarbon-bearing wastes has attracted considerable interest over the past year. Pilot plant tests have demonstrated that the Process is particularly effective in treating mixtures of hydrocarbons and inert solids such as oily soils and oil field production wastes, for example. AOSTRA has granted an exclusive license to UMATAC Industrial Processes Division of UMA Engineering Ltd. to build and use the Process in waste treatment applications. UMATAC are

presently constructing a 240 tonne per day transportable commercial plant which will be used to separate polychlorinated biphenyls (PCB's) from harbour sediments in the Waukegan, Illinois area.

In general, the Process is capable of producing a hydrocarbon-free residual solids which may be disposed of in landfill sites, a solids-free recoverable hydrocarbon for downstream processing and condensed process water which may be treated for reuse or injection into a disposal well depending on the circumstances.

While land spreading of oil field production wastes is acknowledged to be less costly than the use of the AOSTRA Taciuk Process, the Process provides an immediate and permanent disposal option with minimal risk of groundwater contamination from landfill operations.

9.3 The Development of Hydrogen Technologies

The development of hydrogen technology in terms of both its production and utilization is seen as one means by which global warming due to carbon dioxide evolution caused by the combustion of fossil fuels may be combated.

A total hydrogen economy may not be achieved in the foreseeable future. However, steps should be taken now to investigate, for example, alternative sources of hydrogen which do not rely on natural gas reforming and more efficient use of available surplus hydro-gen in the production of transportation fuels from bitumen and heavy oil.

AOSTRA has joined with industry and other government departments and agencies in Canada under the umbrella of the Hydrogen Industry Council to expand research and development of hydrogen technologies on a broad front.

9.4 In Situ Environmental Program

The AOSTRA In Situ Environmental Studies Program consisted of conducting environmental audits of four AOSTRA in situ pilot projects; Norcen-Bodo, Husky-ATS, AOSTRA-UTF, and Amoco-GLISP. The Audits have also resulted in several concepts for improved environmental management of our projects. Included are improved verification of source and disposal water line integrity and the necessary to determine complete elemental analysis of disposed waste sand.

AOSTRA actively participate din the development of a Canadian Heavy Oil Association (CHOA) Environmental Committee and the planning of an environmental seminar for the fall of 1989.

9.5 Environmental Audits

AOSTRA has initiated a program of environmental audits to ensure that established guidelines are being satisfied and to highlight environ-mentally sensitive aspects related to AOSTRA's in situ projects. Audits of four projects were completed and are in progress for two other projects.

10 University Programs

10.1 Lectureships

The new AOSTRA Lectureship Program was announced last year. The program will fund experts from Canada and abroad to travel to Alberta to present seminars or courses to industry and to the research community in areas relevant to AOSTRA's mandate.

10.2 Graduate Scholarships and Fellowships

Post-graduate scholarships and fellowships have been made available over a twelve-year period for oil sands research at the University of Alberta, the University of Calgary, and the University of Lethbridge. Current award holders are identified in the following lists. The scholarships are for a maximum period of two years and the research carried out will normally lead to either a Masters or Doctoral degree. Fellowships are intended to assist post-doctoral scientists in furthering their research training. Many of these individuals will eventually enter the industrial research sphere.

University of Alberta

Bell, D.D.	Le, L.
Bradley, S.	Maslowski, R.M.
Chachrabarty, C.	Mattison, B.W.
Chalaturnyk, R.	Nachel, M.
Cloutis, E.	* Phadke, S.
Eastwood, J.	* Sarma, K.
* Foght, J.M.	Steer, J.G.
Hickey, C.	Tsingas, C.
Khorasheh, F.	* Udey, S.N.

University of Calgary

Chang, K.	* Maier, R.
Eastick, R.	Mehta, S.A.
* Lappin-Scott, H.	Nighswander, J.A.
Lewis, J.M.	

* Fellowship

10.3 University Research Program

AOSTRA continues to support a wide range of oil sands and heavy oil related research projects at Canadian universities. The University Research Program covers many areas of practical interest ranging from fundamental research to new process development for the recovery and upgrading of bitumen and heavy oil. The budget in 1988/89 for support of research in

Canadian universities amounted to approximately $2.7 million. Brief descriptions of the projects carried out in 1988/89 follow:

1. Dr. M.C. Baird of Queen's University is developing water-soluble catalysts whose aqueous solutions will catalyze the hydrogenation of unsaturated linkages of bitumens under biphasic conditions. This project has been funded at $80,000 over two years.

2. Dr. L.A. Behie and Dr. W.Y. Svrcek of the University of Calgary are generating basic kinetic data for ultrapyrolysis of Alberta heavy oil using a novel micro-reactor system and determining product distribution. Funding of the work amounts to $203,000 over three years.

3. Dr. D.W. Bennion and Dr. R.G. Moore of the University of Calgary are continuing their investigation of mechanisms of dry and wet in situ combustion in oil sands and the low temperature oxidation of bitumen. These researchers have been funded over the past thirteen years for a total of $2,293,764.

4. Dr. P.M. Boorman, Dr. R.A. Kydd and Dr. T.S. Sorensen of the University of Calgary are developing hydrocracking catalysts capable of being used under relatively mild temperature conditions to enhance the yield of liquid products with low aromaticity. This work and earlier studies by Dr. Boorman have been funded at $619,971 since 1976.

5. Dr. R.M. Butler of the University of Calgary is conducting theoretical and physical model studies of the steam-assisted gravity drainage process for the recovery of heavy oils and bitumen. Funding of this three-year project and previous work amounts to $912,500.

6. Dr. P.M. Byrne of the University of British Columbia is studying stress, deformation and flow of fluids in oil sand masses adjacent to excavations. This one-year project and earlier work with Dr. Y.P. Vaid have been funded in the amount of $86,918.

7. Dr. F.S. Chute and Dr. F.E. Vermeulen of the University of Alberta have been measuring electrical properties of oil sands, developing physical models of electrical heating processes, and evaluating the use of electrical power for selective heating of oil sands. Their research has been funded in the amount of $837,633 over a period of twelve years.

8. Dr. D.E. Cormack of the University of Toronto is developing a three-dimensional numerical simulator for application to the steam assisted, horizontal well, gravity drainage process and investigating the effects of non-condensable gases on steam chamber development. Funding of his current two-year project and earlier studies amounts to $215,310.

9. Dr. J.W. Costerton of the University of Calgary is investigating the use of bacteria as injection agents to prevent coning and to improve conformance by selectively plugging high permeability zones. A total of $442,000 has been allotted to this and earlier projects over five years.

10. Dr. P.J. Crickmore of the University of Alberta is using fractal analysis as a tool in solving problems in the recovery of bitumen from oil sand. The cost of this project is $77,080 over two years.

11. Dr. M.B. Dusseault of the University of Waterloo continued a project to delineate the volume and permeability changes that occur under the low shear stress conditions that accompany high pressure injection during in situ recovery. He also began a new project to obtain geotechnical data needed to assess novel technological approaches to overburden and tailings waste management in mining operations. Funding of these studies and previous geotechnical work by Dr. Dusseault amounts to $494,757 over twelve years.

12. Dr. S.M. Farouq Ali of the University of Alberta is studying the use of small amounts of carbon dioxide gas to improve the water-flooding process for recovery of Alberta light oils, developing new methods of mobility control that will improve recovery of heavy oil or bitumen from the Athabasca and Lloydminster deposits and constructing a computer program to model formation fracturing and recovery during steam-injection operations. Funding of these projects amounts to $1,871,068 over ten years.

13. Dr. M.R. Gray of the University of Alberta is developing methods to characterize the kinetics of refining processes in terms of the functional groups of the components of bitumen feedstock. This three-year project, and earlier work with Dr. I.G. Dalla Lana have been funded in the amount of $350,000.

14. Dr. L.G. Hepler of the University of Alberta is investigating the colloidal properties of various clay/oil/water systems, primarily for application to water and tailings treatment. He is also measuring the thermodynamic properties of bitumen/gas systems and the kinetics of bitumen oxidation, to obtain quantitative relationships useful in modelling in situ recovery processes. Funding has amounted to $966,988 over ten years.

15. Dr. I.E. Hutcheon of the University of Calgary is conducting laboratory work and field studies to characterize the dissolution and precipitation of minerals in thermal processes for recovery of bitumen. Funding of this

eight-year project amounts to $782,290.

16. Dr. J.B. Hyne and Dr. P.D. Clark of the University of Calgary are studying the chemical reactions in bitumen that cause gas to be produced as a reservoir is steamed, and their effects on the physical properties of the bitumen. The cost of this project and earlier work by Dr. Hyne is $537,505.

17. Dr. A. Jeje of the University of Calgary is studying the fundamental processes in the separation scheme of the hot-water bitumen extraction process. The amount of funding for this two-year project and for an earlier study on in situ oil recovery by C02 injection is $118,520.

18. Dr. F.W. Jones and Dr. J.S. Rogers of the University of Alberta are developing an improved tiltmeter to measure tilt of the surface induced by a recovery process. This instrument is potentially useful for monitoring the progress of in situ recovery processes and is being tested at the GLISP site. This seven-year project cost $382,348.

19. Dr. N.E. Kalogerakis and Dr. A.K. Mehrotra of the University of Calgary are attempting to measure and model the distribution of carbon dioxide between oil and brine under in situ recovery conditions. $302,923 has been allotted to this and earlier projects over an eight-year period.

20. Dr. E. Kanasewich and Dr. E. Nyland of the University of Alberta are developing and testing algorithms that interpret signals received by geophones to monitor and locate sources of microseisms induced by in situ processes. Total funding of $896,864 has been allocated for this and earlier work over an eight-year period.

21. Dr. G. Karim of the University of Calgary is investigating the processes of ignition, flame propagation and quenching in low velocity streams of fuel in vapor-air mixtures in porous media. This three-year project and earlier work were funded at $156,920.

22. Dr. S. Levine and Dr. B.D Bowen of the University of British Columbia have been using theory and experiment to identify the mechanisms by which fine particles and clays stabilize emulsions. This project has been funded in the amount of $312,416 over five years.

23. Dr. F.J. Longstaffe is carrying out a detailed regional study of natural diagenesis in sands, sandstones and shales of the Clearwater Formation, Cold Lake area, Alberta. This two-year project and earlier study cost $123,817.

24. Dr. B.C.-Y. Lu of the University of Ottawa is conducting laboratory experiments to measure phase equilibria of mixtures of water and bitumen under the conditions obtained in steam processes. Also, Dr. Lu is examining the internal consistency of existing data on gas solubilities in bitumen which are available to AOSTRA. Funding amounts to $286,460 over five years.

25. Dr. J. Masliyah of the University of Alberta is investigating the use of flotation columns as an alternative to traditional flotation cells for the recovery of bitumen. He is also carrying out rheological studies of bitumen/solids/water emulsions. The cost of this two-year research and earlier work is $330,560.

26. Dr. A.K. Mehrotra and Dr. W.Y. Svrcek of the University of Calgary are measuring and correlating the viscosity, density and gas solubility of Alberta bitumens. This two-year project and earlier work were funded at $285,787.

27. Dr. N.R. Morgenstern and Dr. J.D. Scott of the University of Alberta are measuring the strength, deformability and permeability of oil sands at the high temperatures and pressures that are found in in situ thermal processes. The objective is to develop a geomechanical model for reservoir assessment. This work and earlier studies by these researchers have been funded to a total of $1,064,209 over a ten-year period.

28. Dr. K. Muehlenbachs of the University of Alberta is carrying out isotopic studies on bitumen upgrading. He is monitoring hydrogenation of bitumen as well as influence of coal and coal-based catalysts on bitumen upgrading. His research has been funded in the amount of $203,000 over a period of three years. Dr. Muehlenbachs has also been responsible for the project originally headed by C.M. Scarfe who died on July 20, 1988. The dissolution kinetics of calcite and dolomite is being measured under in situ recovery conditions, for application to modelling of reservoir fluid chemistry. $94,095 was budgeted over three years.

29. Dr. S.G. Pemberton of the University of Alberta is investigating regional stratigraphy and depositional history of the Grand Rapids Formation in the Cold Lake and Wabasca deposits, and of the South Athabasca oil sand deposit. Traces of the fossil workings of worms provide good paleontological control and facies predictive capabilities beyond the borehole. Funding for his current two- and three-year projects and earlier work is $436,265.

30. Dr. D.Y. Peng of the University of Saskatchewan is analyzing the application of continuous thermodynamics to develop improved equations of state for bitumen/gas system. A total of $126,240 was budgeted for four years.

31. Dr. V.R. Puttagunta of Lakehead

University is developing general correlations to predict the viscosity of bitumen gas mixtures in all Alberta oil sands formations under in situ recovery conditions. The project is funded at $40,000 over a two-year period.

32. Dr. J.D. Scott, Dr. N. Kerr and Ms. E.A. Richards of the University of Alberta are designing and manufacturing a geotextile filter to be used in ambient temperature, heavy oil production well as well as in a thermally stimulated heavy oil or oil sand production well. This work and an earlier study have been funded at $129,566 over three years.

33. Dr. T.J.T. Spanos of the University of Alberta is developing mathematical expressions that describe multiphase flow in heavy oil reservoirs and the propagation of seismic waves through an oil sand deposit. The research cost is $452,973 over eight years.

34. Dr. O.P. Strausz of the University of Alberta is assessing the merits and future potential of superacids for the hydrocracking of bitumen and heavy oil, for their demetalation and for the production of feedstocks in conventional refining. He has been conducting several continuing in-depth research projects to characterize different aspects of the chemistry of bitumen. These involve the identification and quantification of compound types and geochemical markers, studies on the chemical and thermal degradation of asphaltenes and resins, and the influence of various catalysts on these processes, identification of the causes of poor separability of some bitumens, and the design of new upgrading technology. Total funds spent and committed in the period 1977 to 1989 amount to $3,300,184.

35. Dr. E.L. Tollefson of the University of Calgary is investigating the technology of upgrading coke, pitch, heavy oil, and bitumen. This work and earlier studies on methods of coke desulphurization have been funded at a level of $778,370 over ten years.

36. Dr. J.K.S. Wan of Queen's University is investigating the use of microwave heating of dilute catalysts to hydrocrack fractions of bitumen. Also, Dr. Wan is improving his similar process developed earlier for AOSTRA to generate olefins from methane and other alkanes. Total funding is $568,264 for eight years.

37. Dr. N.C. Wardlaw of the University of Calgary is investigating rock-pore properties in carbonate and sandstone reservoirs important to enhanced oil recovery processes. This project and earlier work have been funded at $537,384 over a six-year period.

38. Dr. D.W.S. Westlake of the University of Alberta is investigating the ability of microorganisms to change the chemical composition of asphaltenes by monitoring for changes in the ratio of aliphatic/aromatic hydrogen, for the incorporation and/or removal of oxygen into molecules and for changes in molecular weight. This two-year project cost is $87,500.

The AOSTRA University/Industry Access Program provides industry with ongoing research reports, regular interaction with researchers, non-exclusive technology use rights and an opportunity to participate in project evaluation. An Associate Membership category allows companies to obtain membership privileges with somewhat restricted participation in project evaluation and technology use rights. In 1988/89, fifteen companies participated in the program as full or associate members at annual fees of $50,000 or $10,000 respectively.

11 AOSTRA–Alberta Research Council Program

AOSTRA continues to support laboratory research on oil sands and heavy oils at the Alberta Research Council (ARC). This research can be categorized into two main groups: "Core Research" and "Strategic Research".

11.1 Core Research Program

The Core Research Program focuses mainly on the regional and generic problems which are common to much of the industry. The Program provides an interface between fundamental and applied industrial research, complements expertise in universities and industry, and aids technology transfer and problem solving.

The Core Research Projects are currently funded jointly with ARC and in some cases, another government agency. Three major areas are included in the Core Research Program.

1. Oil Sands and Hydrocarbon Recovery Research:
This program is jointly funded by AOSTRA and ARC. AOSTRA's contribution is 44% of the $3.0 million program, i.e. $1.31 million, in the 1988/89 fiscal year. The joint program is a means by which industry and government can combine their efforts to maintain research and to preserve the technology and expertise to date. With active participants from the industry, six multi-disciplinary projects were designed to address an identified technical need, with both short and longer term objectives and schedules.

These six technical projects, that involve a total of approximately 30 man-years of professional and technical efforts, are closely coordinated with one another. Notable achievements in the 1988/89 fiscal year include:

- The influence of capillary pressure on the fluid dynamics of steam front propagation in an unconsolidated sand matrix was determined using a computed tomographic technique.
- The mechanisms for propagation of foam in a reservoir were developed in a series of conformance control experiments.
- Using a numerical foam transport model, optimal strategies for application of foaming agents in an existing field pilot were evaluated.
- Experiments were completed in which three novel, in situ recovery processes using additives in a hot water flood were tested; as compared to hot water alone, significant improvement in recovery was obtained.
- Criteria for the design of scaled models were developed in order to predict field pilot performance using laboratory data.
- New techniques were developed for reducing scale deposition in the near well region of a thermal production well.
- A high pressure visual cell was fabricated to measure ternary phase behaviour of bitumen-gas mixtures in the presence of steam-water.
- A heat transfer apparatus was constructed to investigate enhanced heat transfer mechanisms under in situ conditions.

The transfer of technology from this program is via the AOSTRA/ARC/ Industry Access Program through which companies are involved in all stages of project definition, direction and management, and obtain the technical information generated from the program. The annual membership fee for the Access Program currently amounts to $60,000. The Technical Committee and Project Sub-Committees, in which all Access member companies have representation, have made substantial progress during the past year to ensure that technical directions of the Research Program remain relevant and responsive to identified needs. The membership has grown from four to nine companies in 1988/89.

2. Regional Geology Studies:
This program is supported on an equal tripartite basis by AOSTRA, ARC and the Alberta Department of Energy, with each agency contributing $400,000 per annum. The research program focuses on regional geological characterization of the unmapped portions of the oil sands deposits and on parameter estimation for detailed reservoir modelling.

The resource characterization studies provide fundamental insight into the stratigraphic and structural setting of the oil sands deposits, define the sedimentologic and mineralogic framework of the reservoir horizons, and document fluid distribution and saturation. Acquisition of this information yields baseline data against which decisions on resource assessment, development and recovery strategies can be addressed. Complementary to these more regional investigations, the detailed geological reservoir modelling studies are focused on the finer scale attributes of oil sand and heavy oil reservoir fabric. It is intended to provide more sophisticated insight into the identification, scaling and quantitative modelling of geological petrophysical parameters.

The technical information generated from the Program is also made available to the industry through the Access Program.

3. Hydrocarbon Processing and Upgrading Project:
This is the second year of a new five-year arrangement between AOSTRA and ARC on a 50/50 basis. In the 1988/89 fiscal year, approximately $800,000 was expended. During the year, the major activities in the program were concentrated in three areas:

- Evaluation of a new high conversion hydrocracking process;
- Investigation of the coke formation mechanism in upgrading processes; and
- Development of novel catalysts for bitumen hydrotreating.

In high conversion projects, pilot plant tests of a novel bitumen upgrading process by using homogeneous catalysts were conducted. Significant progress was achieved in understanding process chemistry and hydrodynamic behaviour of process fluids in the reactor, therefore, a theoretical model to optimize reactor design was formulated. A technical and economic evaluation was initiated during the year.

The conversion of liquid hydrocarbons to solid coke under thermal process conditions was investigated. The understanding of the mechanisms of coke formation will eventually lead to improvements in the reduction of coke formation in commercially operated coking processes.

Exploratory research was also initiated to develop a "designer" catalyst of low severity, high activity hydrotreating

processes. The work was focused on identifying critical properties of high performance catalysts.

11.2 Strategic Research Program

The Strategic Research Program is designed to provide a confidential forum for applied proprietary research and development to meet AOSTRA's specific needs in all areas of operation. The Strategic Research Program has three broad objectives:

- To apply concepts, results and insights gained from laboratory research to field situations.
- To address specific problems from field operations.
- To investigate and evaluate AOSTRA technology for potential broader application to resource development.

The program is funded 100% by AOSTRA; approximately $1.645 million was expended in the 1988/89 fiscal year. The Program Committee, which consists of representatives from three different Directorates of AOSTRA, as well as ARC, is continually monitoring progress of the Program to conform with AOSTRA's priorities. Currently, the program consists of the following major areas of activity:

- Water coning suppression;
- Sands exclusion in wells;
- Controlling fluid communication in reservoirs;
- Microbial application to reservoir conformance control;
- Geological delineation of UTF reservoir;
- Steam application after stimulation;
- Artificial lift production research to improve the pumping efficiency for heavy oil production;
- Improvement of bitumen recovery efficiency for the hot water extraction processes;
- Further development of high conversion hydrocracking process for bitumen upgrading.

Much progress has been achieved in 1988/89 and three new inventions are currently being reviewed by the AOSTRA patent attorney.

11.3 Sample Bank

In addition to the research and development programs, such as the "Core Research Program" and the "Strategic Research Program", AOSTRA also continues to support a service project in ARC, the Sample Bank, with a 2–4 person-year effort. Approximately $150,000 was expended in 1988/89. The prime purpose of the Sample Bank is to support research and development of all phases of oil sands and heavy oil technology by providing "standard" oil sands, bitumen and other related samples to research workers around the world. The Sample Bank distributed a total of 25 tonnes of bitumen, oil sands, heavy oil and related materials in 71 shipments. The value of these shipments was $17,971.50.

12 Programs at Other Research Organizations

12.1 Computer Modelling Group

AOSTRA and the Computer Modelling Group (CMG) entered into a five-year program of Reservoir Simulation Research beginning April 1, 1986. Initially, two advanced thermal simulators, Thermal Wellbore Simulator (THEWS) and Steam-Additive Reservoir Simulator (STARS), were developed. These two simulators have been further validated and enhanced, and in addition, both dual porosity and dual permeability models were subsequently incorporated into STARS. CMG also provides support to AOSTRA staff with training, installation and consulting, in the use of thermal model ISCOM, STARS and black oil model IMEX.

In 1988/89, AOSTRA supported CMG to the extent of $220,000 which is equivalent to two person-years of effort.

12.2 Petroleum Recovery Institute

During the 1988/89 fiscal year AOSTRA continued to support the research program at the Petroleum Recovery Institute by matching industry membership contributions to a maximum of $700,000 plus AOSTRA conducted strategic research to support the core program at PRI at a cost of $300,000.

Four major areas of research are currently underway at the Petroleum Recovery Institute in the field of enhanced oil recovery technology. The research areas are gas flooding, sweep efficiency, heavy oil and chemical flooding. Industry as well as AOSTRA has access to the results of this work which are available for potential field application. In addition, the Petroleum Recovery Institute provides technical expertise to AOSTRA for the analyses of the performance of AOSTRA projects and for special laboratory studies.

In 1988, AOSTRA negotiated an agreement with the Petroleum Recovery Institute to patent and market technology developed at the Institute.

12.3 Saskatchewan Research Council-Multi Client Research Program

AOSTRA participates in a number of multi-client research projects being conducted by the Saskatchewan Research Council. AOSTRA receives the results of research being conducted in miscible displacement, emulsion research, thermal studies, sand control studies, in situ combustion and enhanced heavy oil recovery by carbon dioxide injection.

13 International Programs

China

AOSTRA continues to conduct eight joint projects with the Research Institute of Petroleum Exploration and Development (RIPED) which is the central research institute for the Chinese petroleum industry. Under these projects, research work has been conducted in China and Canada and specialists have been exchanged between the two countries for up to a year.

AOSTRA continues to further its relationship with China and has negotiated exchange agreements and joint projects with several oil fields and with CNPC, the China National Petroleum Corporation. These have lead to China joining AOSTRA's University and ARC Access programs and to the sale of major equipment to China by Alberta companies.

Soviet Union

Relationships with the Soviet Union continue to grow with a delegation visiting AOSTRA in August and arrangements being concluded for the exchange of specialists for a six-month period.

Hungary

Under the terms of an exchange memorandum with the Hungarian Hydrocarbon Research Institute a technical expert from Hungary spent six months in Alberta working on drilling programs and long term planning while a Canadian expert is currently in Hungary for six months working on in situ combustion in light oil reservoirs.

Czechoslovakia

AOSTRA visited Czechoslovakia and signed a technology exchange agreement. Czechoslovakia is particularly interested in Alberta technology related to sour gas production, transportation and processing and in leak detection for gas transmission pipelines.

Romania

AOSTRA visited Romania and concluded work under its old Memorandum of Understanding and signed a new one. Under this MOU, AOSTRA is publishing a Romanian book and is considering test operating a Romanian manufactured greasless compressor. Romania has extensive expertise in in situ combustion but could use Canadian technology in slant and directional drilling.

Jordan

AOSTRA continues to work with Petro-Canada International in the evaluation of Jordanian oil sand deposits.

Turkey

AOSTRA signed a Memorandum of Understanding with the Turkish National Oil Company and a Canadian expert visited Turkey for three weeks to assess heavy oil recovery projects using carbon dioxide.

Germany

AOSTRA continues to have joint projects and technology exchange with Germany in the area of bitumen upgrading and co-processing. AOSTRA is negotiating an exchange agreement with Germany to facilitate further technology exchange and joint projects.

Norway

AOSTRA and Norway are particularly interested in directional drilling and well completions and are negotiating an exchange agreement in this area.

Japan

AOSTRA continues to work with Japan in the area of upgrading of Alberta bitumen and in co-processing. AOSTRA evaluated the Idemitsu Kosan process and has negotiated a Memorandum of Understanding with the National Research Institute for Pollution and Research in Tslekula.

Venezuela

AOSTRA has maintained active cooperation with Venezuela, which has some of the largest heavy oil and oil sand deposits in the world. AOSTRA recently signed a new Memorandum of Understanding with Venezuela and in recent meetings agreed to cooperate and exchange technology and technical experts in the area of bitumen upgrading, university research and field piloting of new technologies.

Brazil

AOSTRA continues to work with Petrobras on the use of the AOSTRA Taciuk Processor for processing of Brazilian Oil Shale fines and filter coke and recently extended these studies to the use of the Processor for clean up of refinery sludge.

Trinidad

Trinidad has a significant oil sands deposit which is amenable to recovery by surface mining and processing. AOSTRA is currently evaluating this deposit for application of the AOSTRA Taciuk Processor.

Cuba

Cuba has recently become a heavy oil producer and is rapidly expanding its resource evaluation and production. AOSTRA has signed a Memorandum of Understanding with Cuba and is assisting Cuba in evaluating heavy and extra heavy oil resources where Canadian technology may be applied. AOSTRA is also working with Canadian consultants in the introduction of advanced drilling technology to Cuba.

U.S.A.

AOSTRA along with the Department of Energy, Mines and Resources, the Department of Energy of the United States of America and the Saskatchewan Department of Energy and Mines continues to play an active role in the Canada/U.S.A. Memorandum of Understanding. AOSTRA has exchanged seismic data from its Gregoire Lake Pilot, cooperated in reservoir characterization studies and is currently in the process of exchanging results of university research.

UNITAR

As one of the founding members of the United Nations Information Center for Heavy Crude and Tar Sands, AOSTRA continues to play an active role in the center's activities. During August, AOSTRA acted as host sponsor of the 4th UNITAR/UNDP International Conference on Heavy Crude and Tar Sands in Edmonton, Alberta. At this conference over 800 delegates attended from 37 countries with 206 papers presented from authors in 24 countries.

14 Training Programs

AOSTRA continues to provide training opportunities for young Albertans to obtain experience in hydrocarbon recovery and processing. Four main programs were conducted.

NAIT/SAIT Program

This employed sixteen NAIT/SAIT students for a four-month period during the summer between their first and second academic year of training. Students were employed on a variety of AOSTRA projects.

Co-op Program

This employs engineering students who are on the industrial portion of their co-op training program. Students are employed at AOSTRA's Calgary Office for periods of four or eight months with up to six students at any one time being employed.

New Graduate Assistance Program

This program gives new university graduates in engineering and geology an opportunity to work for two years and obtain their work experience required for professional registration. Eight recent graduates are employed at AOSTRA's Calgary and Edmonton offices on this program.

University Summer Student Program

This program takes top quality students who have completed second or third year university training and employs them with university professors who are working on AOSTRA projects thus giving them the opportunity to become familiar with the potential of doing graduate work in hydrocarbon recovery and processing. AOSTRA employed twenty-one students on this program.

15 Industrial Post-Doctoral Fellowship Program

In 1983, AOSTRA initiated its Industrial Post-Doctoral Fellowship Program which was designed to assist the transition of post-doctoral researchers from an academic to an industrial environment. During the two-year term of the award, valued at $22,500 per year, the AOSTRA Industrial Fellow conducts a research project in the laboratory of the sponsoring company which provides the space, equipment, and support personnel required for the proper conduct of the research.

Currently there are three holders of the award:

Dr. Keng Haut Chung is studying the use of membranes for the clarification of recycle water from oil sands mining operations. This work is being conducted at the Syncrude Canada Ltd. Research Laboratory in Edmonton, Alberta.

Dr. Khoon-Sin Tan is responsible for evaluation of Nuclear Magnetic Resonance (NMR) technology for use by Syncrude through the design and completion of a variety of experiments and to act as a technical interface with external laboratories carrying out contract NMR work.

Dr. Laurie J. Danielson is working on the fundamental aspects of the sludge disposal problem at Syncrude with the aid of Scanning Electron Microscopy, X-Ray Diffraction and NMR Spectroscopy.

16 Inventors Grant Assistance Program

The Inventors Grant Assistance Program (IGAP), first implemented in 1983, was continued during fiscal 1988. The purpose of IGAP is to encourage and assist inventors to develop inventions beyond the idea and concept stage so that conventional funding for commercialization may be obtained. Amounts to a maximum of $50,000 may be awarded to individuals or companies for use in developing inventions. AOSTRA does not earn any use rights to the inventions and the only requirement on the part of the inventor is a commitment to use the funds in the development of the invention and to supply both accounting and technical reports to AOSTRA.

This continues to be a popular program with a total of 14 applications being reviewed during the year. Seven of these applications were approved for funding as follows:

IGAP Recipient	Amount of Grant	Activity Supported
371963 Alberta Ltd.	$ 50,000	To further work on the cable oil lifting system
Oleophilic Sieve Development	$ 19,000	To pursue patent protection for improvements to the Oleophilic Sieve Process for bitumen extraction from oil sands plant sludge
Maria J. McGrath	$ 10,000	To pursue a patent for the recovery of bitumen from tailings or mined tar sand in microfine vacuum filtration apparatus using solvent technique
Foothills Diamond Coring	$ 42,000	To complete the design, construct a prototype and test a device for coring a previously drilled and logged well for which subsequent core data is required from selected intervals
Veltom Industries Ltd.	$ 46,100	To support fabrication and testing of the Heavy Oil Sand Slurry (Hoss) Pump
D. Moore and M. Wawrzynowski	$ 40,000	To construct, test and patent a"Downhole Adjustable Bent Housing"
D. Uttley	$ 30,000	To construct and test a prototype of a concept to increase the upward velocity in production tubing to defeat sand settling action on the pump.

Grants awarded under IGAP have totaled $1,102,515 since the program was implemented.

17 AOSTRA Technology Transfer and Commercialization

AOSTRA has a fully operative Technology Transfer and Commercialization office that provides access to AOSTRA owned technology and programs. Access to this technology is easily obtained by contacting the Manager, Technology Transfer and Commercialization at either of AOSTRA offices in Calgary or Edmonton. In 1988 AOSTRA entered into 170 agreements with industrial representatives who wished to examine either reports or technical packages in confidence.

The wide range of AOSTRA technology covers mining, bitumen extraction and upgrading; in situ recovery methods; enhanced oil recovery methods and institutional research. AOSTRA technology was highlighted at the 4th International Conference on Heavy Crude and Tar Sands held in Edmonton August 7-12, 1988 under the auspices of UNITAR/UNDP. An AOSTRA technology display was available at the UNITAR/UNDP Conference to provide the conference delegates with an overview of AOSTRA technology and research.

In 1988 AOSTRA entered into 35 technology transfer agreements of which 29 have been fully executed.

These agreements represent a total value of $10,016,583. Six pending agreements represent a value of $7,907,500. The number and value of these agreements is indicative of growing interest by industry of AOSTRA technology as it develops from institutional research and experimental field projects.

AOSTRA invites enquiries for technology transfer on completed projects; currently active projects; the data base management system; and the institutional research programs.

The two institutional programs are outlined as follows:

17.1 University Research Projects

The university research program covers many areas of practical interest ranging from fundamental research to new process development for the recovery and upgrading of bitumen and heavy oil. A total of eighteen companies and research institutes have accessed the results from the university projects as full or associate members. A full membership fee of $50,000 per annum entitles a member rights to use all results and the processes developed in the research, attend all meetings and the right to participate on the panel that evaluates applications and recommends what should be funded. Associate members pay $10,000 per annum that entitles the right to attend all meetings and to purchase the right to use processes.

17.2 Joint AOSTRA/ARC Core Research Program

This $3.0 million program is jointly funded by AOSTRA and the Alberta Research Council and is an ongoing oil sands and heavy oil research program. As currently structured, the Core Research Program consists of six projects which have been specifically formulated to technical needs identified by industry. The program is based on an annual industry access fee of $60,000 that provides for the non-exclusive use of the technology and for making input to the content and direction of research by direct involvement with the personnel of AOSTRA and ARC.

17.3 AOSTRA Technology Transfer and Commercialization

As outlined in Section 1.8, the ADBS II provides full data storage, access, and reporting capabilities for in situ pilot projects. The system is utilized by project participants on seven active AOSTRA/ Industry in situ projects. Licensing options include:

(1) Time-sharing access to project data stored on AOSTRA's in-house computer system. Users must be participants in the project (i.e. operator or partner or licensees), since all data within ADBS II is confidential. System charges are directly related to the volume of data and amount of use.

(2) Use of the ADBS II on users' own computers. In this case, AOSTRA installs and supports a customized version of the software on the user's own system. The system is well suited for an engineering "workstation" environment, and can be installed on workstations from several major computer companies.

18 Economic Analyses

Economic evaluations are utilized by AOSTRA to help determine the direction of research required to develop new and improved technology. Proposed and active research projects are evaluated to determine their potential economic viability, and completed projects are evaluated to establish the potential value of technology available for sale or licensing. Economic studies provided by applicants, project participants, and studies developed by AOSTRA are utilized.

An extensive cost engineering database is being developed by AOSTRA specifically for bitumen and heavy oil production and processing. This database will provide capital and operating cost data required for AOSTRA's economic evaluations, and will provide a basis for evaluating economic studies submitted to AOSTRA.

19 Publications, Conferences and Workshops

19.1 Publications

- The fifth technical report in the AOSTRA Technical Publication Series — A Review of Analytical Methods for Bitumens and Heavy Oils — was published in July, 1988.
- The third report of a series being published under a joint Memorandum of Understanding between AOSTRA and the United States Department of Energy, entitled Characterization of Oil Sands Resources was also published during 1988.
- The proceedings of the 4th International Conference on Heavy Crude and Tar Sands which was held in Edmonton in August, 1988, are currently being edited and typeset and will be available for sale in July, 1989.

- The AOSTRA Journal of Research and the TARpaper are published quarterly.

All publications are available upon request to the AOSTRA Library and Information Services (see address on page 17).

19.2 Conferences & Workshops

- AOSTRA was pleased to co-sponsor and host the 4th International Conference on Heavy Crude and Tar Sands in Edmonton during August, 1988. More than 700 people attended from more than 36 countries. In excess of 200 Technical papers presented in a full range of subject categories made this one of the most comprehensive conferences ever held on this subject.
- In October, 1988, the annual meeting of the participants in the University Access Program was held in Banff, Alberta. This meeting gives researchers and company representatives an opportunity to discuss work being carried out at the University and have an input in future directions.

20 Awards

AOSTRA was very pleased to revive the Karl A. Clark Distinguished Service Award during 1988. The Award is presented to individuals who have made important contributions to the overall realization of the commercial potential of Alberta's oil sands resources. An external panel of five people was appointed to review 17 nominations submitted. The successful candidate will be presented with the award in May, 1989.

21 AOSTRA library and Information Services (ALIS)

AOSTRA Library and Information Services' multi-disciplinary team of technical information officers and support staff in both Edmonton and Calgary provides fast, accurate information on oil sands, heavy oil and enhanced recovery processes. Hard copies of all material are available at both sites.

In addition, AOSTRA's confidential information has also been computerized and the hard copy filing system is in place. This information consists of:

- AOSTRA/Industry Field Pilot Projects;
- AOSTRA/University Research Program Agreements;
- AOSTRA/Industry Mining, Upgrading, Extraction Projects;
- AOSTRA/ARC Core and Strategic Geology Programs;
- IGAP — Inventors Assistance Program
- AOSTRA Patents.

ALIS continues to distribute the TARpaper, the AOSTRA Journal of Research and all AOSTRA Publication Series material.

22 Patents

22.1 AOSTRA Patents

The following patents and patent applications are assigned to AOSTRA:

a) Canadian Patents

Patent No.	Date Issued	Patent Title
1,102,234	Jun 2/81	Gaseous and Solvent Additives for Steam Injection for Thermal Recovery of Bitumen from Tar Sands (D.A. Redford and M.R. Hanna)
1,120,418	Mar 23/82	Process and Apparatus for Thermally Processing Heavy Hydrocarbon-Containing Liquids (W. Taciuk)
1,121,749	Apr 3/82	Apparatus and Process for Recovery of Hydrocarbons from Inorganic Host Materials (W. Taciuk)
1,122,015	Apr 20/82	Process for Microbiologically Leaching Coke (T.R. Jack et al)
1,134,174	Oct 26/82	Two-Phase Wet Steam Flowmeter (1) (D.S. Scott and E. Rhodes)
1,158,458	Dec 13/83	Variable Drive for Pump Jack (D.L. Buckler)
1,170,444	Jul 10/84	Use of Hydrogen-Free Carbon Monoxide with Steam in Recovery of Heavy Oil at Low Temperatures (J.B. Hyne and J.D. Tyrer)
1,171,382	Jul 24/84	Electrophoretic Process for Separating Aqueous Mineral Suspensions (R. A. Ritter)
1,189,444	Jun 25/85	Additive for Inclusion in a Heavy Oil Reservoir Undergoing Steam Injection (J.B. Hyne and P.D. Clarke)
1,206,465	Jun 24/86	Catalytic Sulfur Removal from Hydrocarbons (P.M. Boorman et al)
1,210,358	Aug 26/86	Process for Upgrading a Heavy Viscous Hydrocarbon (I.H. Lutz) (Acres Davy McKee D.M. International, Inc., Houston, Texas)
1,220,646	Apr 21/87	Two-Phase/Flowmeter (2) (D.S. Scott and E. Rhodes)
1,225,129	Aug 4/87	Commutator (R.A. Ritter)
1,235,652	Apr 26/89	Method for Obtaining Horizontal Fractures in an Oil Reservoir (T. Harding et al)
1,239,088	July 12/88	Method for Controlling Water Coning in Oil Wells (R.W. Luhning and K.R. Ronaghan)
1,241,293	Aug 30/88	Microwave Induced Catalytic Conversion of Methane to Ethylene and Hydrogen (J. Wan)
1,248,069	Jan 3/89	Apparatus for Continuously Separating Particulate Solids from Liquid Suspensions (R.A. Ritter)
1,844,022	Mar 19/85	Use of Surfactants to Improve Oil Recovery During Steam Flooding (E.E. Isaacs and D.R. Prowse)

b) Canadian Patent Applications

Application No.	Date Filed	Patent Application Title
369,403-8	Jan 27/87	Wet Combustion Process (D.W. Bennion et al)
379,072	Feb 22/83	Improved Process for Recovery of Residual Bitumen from Tailings from Oil Sand Extraction Plants (E.L. Tollefson and E.S. Hall)
517,837	Sept 9/86	Pressure-Up/Blowdown Combustion - A Channelled Reservoir Recovery Process (R. J. Hallam and J. K. Donnelly)
552,801	Nov 19/87	Microbial Process for Selectively Plugging a Sub-terranean Formation (J.W.F. Costerton)
552,920	Nov 26/87	Steam Drive/Oil Recovery Process Involving Horizontal Boreholes (P. Toma)
574,694	Dec 20/88	Method and Apparatus for Measuring Fluid Viscosity (B.B. Maini)

c) U.S. Patents

Patent No.	Date Issued	Patent Title
4,180,455	Dec 25/79	Process for Thermally Cracking a Heavy Hydrocarbon (W. Taciuk)
4,271,905	Jun 9/81	Gaseous and Solvent Additives for Steam Injection for Thermal Recovery of Bitumen from Tar Sands (D.A. Redford and M.R. Hanna)
4,280,879	Jul 28/81	Apparatus and Process for Recovery of Hydrocarbons from Inorganic Host Materials (W. Taciuk)
4,285,773	Aug 25/81	Apparatus and Process for Recovery of Hydrocarbons from Inorganic Host Materials (W. Taciuk - Lloydminster Version)
4,306,961	Dec 22/81	Process for Recovery of Hydrocarbons from Inorganic Host Materials (W. Taciuk - Tarsand Version)
4,312,234	Jan 26/82	Two-Phase Wet Steam Flow Meter (1) (D.S. Scott and E. Rhodes)
4,438,218	Mar 20/84	Catalytic Sulfur Removal from Hydrocarbons (P.M. Boorman et al)
4,454,023	Jul/Aug/84	Process for Upgrading a Heavy Viscous Oil (Hydrocarbon) (I. Lutz) (Acres Davy McKee DM International, Inc., Houston)
4,458,759	Jul 10/84	Use of Surfactants to Improve Oil Recovery During Steam Flooding (E.E. Isaacs and D.R. Prowse)
4,487,264	Dec 11/84	Use of Hydrogen-Free Carbon Monoxide with Steam in Recovery of Heavy Oil at Low Temperatures (J.B. Hyne and J.D. Tyrer)
4,501,648	Feb 26/85	Electrophoretic Process for Separating Aqueous Mineral Suspensions (R.A. Ritter)
4,506,733	Mar 26/85	Additive for Inclusion in a Heavy Oil Reservoir Undergoing Steam Injection (J.B. Hyne and P.D. Clarke)
4,574,038	Mar 4/86	Microwave Induced Catalytic Conversion of Methane to Ethylene and Hydrogen (J. Wan)
4,574,643	Mar 11/86	Two-Phase Wet Steam Flowmeter (2) (D.S. Scott and E. Rhodes)
4,623,203	Nov 18/86	Commutator (R. A. Ritter)
4,623,442	Nov 18/86	Apparatus for Continuously Separating Particulate Solids from Suspensions (R.A. Ritter)
4,718,489	Jan 12/88	Pressure-up/Blowdown Combustion - A Channelled Reservoir Recovery Process (R.J. Hallam and J.K. Donnelly)

d) U.S. Patent Applications

Application No.	Date Filed	Patent Application Title
06/294.523	Aug 20/81	Variable Speed Pump Jack (D.L. Buckler)
122,814	Nov 19/87	Microbial Process for Selectively Plugging a Sub-terranean Formation (J.W.F. Costerton)
132,803	Dec 14/87	Steam Drive/Oil Recovery Process Involving Horizontal Boreholes (P. Toma)
229,008	Aug 5/88	Recovery of Bitumen or Heavy Oil In Situ by Injection of Hot Water or Low Quality Steam Plus Caustic and Carbon Dioxide (A.S. McKay)
229,349	Jan 29/81	Wet Combustion Process (D.W. Bennion et al)
234,759	Aug 22/88	Method and Apparatus for Measuring Fluid Viscosity (B.B. Maini)
784,933	Oct 7/85	Method for Controlling Water Coning in Oil Wells (R.W. Luhning and K.R. Ronaghan)
834,177	Feb 2/86	Method for Obtaining Horizontal Fractures in an Oil Reservoir (T. Harding et al)

e) Venezuela Patents

Patent No.	Date Issued	Patent Title
1993/79	Aug 7/86	Process and Apparatus for Thermally Processing Heavy Hydrocarbon-containing Liquids (W. Taciuk)
991/80	Jun 10/80	Process for Microbiologically Leaching Coke (J. Zajic et al.)
67/81	Aug 5/86	Gaseous and Solvent Additives for Steam Injection for Thermal Recovery of Bitumen from Tar Sands (D.A. Redford and M.R. Hanna)
785/81	May 9/81	Two-Phase Wet Steam Flow Meter (D.S. Scott and E. Rhodes)
108/82	Jan 22/82	Wet Combustion Process (D.W. Bennion, R.G. Moore and J.K. Donnelly)
1299/82	Jul 21/82	Use of Hydrogen-Free Carbon Monoxide with Steam in Recovery of Heavy Oil at Low Temperatures (J.B. Hyne/J.D. Tyrer)
1803/83	Nov 11/83	Additive for inclusion in a Heavy Oil Reservoir Undergoing Steam Injection (J.B. Hyne and P.D. Clarke)

f) Venezuela Patent Applications

Application No.	Date Filed	Patent Application Title
264	Feb 25/80	Apparatus and Process for Recovery of Hydrocarbons from Inorganic Host Materials (W. Taciuk)

g) Mexico Patent Applications

Application No.	Date Filed	Patent Application Title
179/758	Oct 24/79	Process and Apparatus for Thermally Processing Heavy Hydrocarbon-Containing Liquids (W. Taciuk)
200,744	Mar 24/84	Process for Upgrading a Heavy Viscous Oil (Hydrocarbon) (I. Lutz) (Acres Davy McKee DM International, Inc., Houston)

h) European (EEC) Patents

Patent No.	Date Issued	Patent Title
0-028-666	Apr 6/83	Process and Apparatus for Thermally Processing Heavy Hydrocarbon-Containing Liquids (W. Taciuk) (Belgium, France, Italy, Netherlands, and U.K.)
79,302542.0		(Sweden)
29-65-154..5		(Germany)
0076882	Jul 17/85	Two-Phase Flowmeter (1) (D.S. Scott and E. Rhodes)
84.301888.8	Mar 20/84	Process for Upgrading a Heavy Viscous Oil (Hydrocarbon) (I. Lutz) (Acres Davy McKee DM International, Inc., Houston)

i) Argentina Patent Applications

Application No.	Date Filed	Patent Application Title
279,427	Dec 21/79	Process and Apparatus for Thermally Processing Heavy Hydrocarbon-Containing Liquids (W. Taciuk)

j) Romania Patents

Patent No.	Date Filed	Patent Title
78671	Oct 31/81	Process and Apparatus for Thermally Processing Heavy Hydrocarbon-Containing Liquids (W. Taciuk)

k) Turkey Patents

Patent No.	Date Filed	Patent Title
22129	May 13/86	Process and Apparatus for Thermally Processing Heavy Hydrocarbon-Containing Liquids (W. Taciuk)

l) Japan Patent Applications

Application No.	Date Filed	Patent Application Title
138227/79	Oct 25/79	Process and Apparatus for Thermally Processing Heavy Hydrocarbon-Containing Liquids (W. Taciuk)

22.2 Prior Company Patents (for which AOSTRA has acquired certain licensing rights)

a) Canadian Patents

	Canadian Patent No.	Date Issued	Date Filed	Related U.S. Patent No.	Patent Titles
1.	1125649	01-15-82	12-19-79	4234042	Direct Combustion Stimulation of a Producing Well
2.	1118341	02-16-82	09-14-79	4272487	Indirect Thermal Stimulation of Producing Wells

b) U.S. Patents

	Canadian Patent No.	Date Issued	Date Filed	Related U.S. Patent No.	Patent Titles
1.	3964547	06-22-76	10-29-74	972679	Use of Tar as a Diverter in Steam Operations
2.	4147213	04-03-79	—	—	Combustion Air Injection Well
3.	4234042	11-18-80	06-11-79	1125649	Direct Combustion Stimulation of a Producing Well
4.	4272487	06-23-81	01-01-79	1118341	Indirect Thermal Stimulation of Producing Wells

Tables

Table 1

Oil Sands Technology and Research Fund
Summary of Funds Committed and Disbursed
As at March 31, 1989

Project	Funds Committed	Prior Years' Disbursements	Disbursements April 1/88 to March 31/89	Balance
Institutional Research				
Alberta Research Council				
— Information Centre — ALIS	$ 5,862,107	$ 4,982,438	$ 714,129	$ 165,540
— Oil Sands Research Centre	27,998,886	26,679,876	1,312,005	7,005
— Sample Bank	1,790,301	1,562,140	144,000	84,161
— Regional Geological Program	4,575,280	4,099,355	497,521	(21,596)
— Hydrocarbon Program	2,901,849	2,476,232	388,600	37,017
— Strategic Research Program	4,444,256	2,837,306	1,586,666	20,284
— Marcro Energy Modelling	100,000	51,000	–	49,000
Inventors Assistance Grant	1,145,275	619,461	274,750	251,064
University Contracts	30,797,811	26,083,548	2,864,891	1,849,372
Professorships	4,001,109	3,920,751	743	79,615
New Graduate Assistance Program	425,000	73,598	201,518	149,884
Post Doctoral Fellowships	100,000	68,540	22,500	8,960
Scholarships and Fellowships	4,790,000	2,826,532	419,280	1,544,188
Lectureship Program	12,000	–	–	12,000
ARC Access Program	25,000	10,170	5,896	8,934
University Access Program	175,000	174,168	($2,930)	$3,762
Program Planning and Evaluation	522,000	326,620	39,160	156,220
Petroleum Recovery Institute	4,589,252	3,887,567	700,000	1,685
Centre for Frontier Engineering Research	75,000	50,000	25,000	–
Computer Modelling Group	660,000	440,000	220,000	–
Unitar Conference	379,000	170,194	23,475	185,331
Unitar Management & Operations	161,000	–	110,092	50,908
Completed Projects	2,371,643	2,371,643	–	–
	$ 97,901,769	$ 83,711,139	$ 9,547,296	$ 4,643,334
Mining and Extraction				
Retorting				
— UMATAC	$ 17,752,208	$ 16,748,227	$ 1,004,649	$ (668)
Nova/Husky/Canstar	176,700	176,700	–	–
Shell Canada/Solv-Ex	3,500,000	3,272,707	–	227,293
Terra Energy-Sesa Project	500,000	70,386	192,389	237,225
Tzipa Enterprizes-Ostex Process	100,000	9,918	81,457	8,625
Esso Resources	1,703,500	337,780	1,365,720	–
Syncrude Canada Limited	450,000	–	294,297	155,703
Completed Projects	7,123,283	7,106,588	16,695	–
	$ 31,305,691	$ 27,722,306	$ 2,955,207	$ 628,178

Table 1

Oil Sands Technology and Research Fund
Summary of Funds Committed and Disbursed
As at March 31, 1989

Project	Funds Committed	Prior Years' Disbursements	Disbursements April 1/88 to March 31/89	Balance
In Situ Oil Sands				
Peace River				
— Shell	$ 75,039,351	$ 74,741,939	$ 175,484	$ 121,928
Athabasca				
— Amoco	24,947,108	23,792,526	–	1,154,582
— Amoco/Petro-Canada	17,108,250	13,963,616	1,372,878	1,771,756
— Canterra Energy Ltd.	52,861,000	36,472,754	6,641,372	9,746,874
Cold Lake				
— B.P.	25,596,000	23,933,996	13,971	1,648,033
— B.P./Petro-Canada	1,499,250	1,150,150	–	349,100
— Bow Valley Industries	17,772,000	12,087,356	884,225	4,800,419
— Suncor - Ft. Kent	400,000	118,979	–	281,021
Alpha Engineering	6,250	1,000	2,100	3,150
Simtech Consulting	65,900	32,631	9,043	24,226
W.T.C. Water Treatment Project	700,000	340,401	34,599	325,000
Shell Water Treatment Project	700,000	678,297	–	21,703
Fekete Thermal Software Program	100,000	–	97,216	2,784
Simons Consulting – Coning Project	96,200	–	75,203	20,997
Maurer Drilling	42,126	–	42,126	–
Engineering Studies Program	300,000	19,118	186,274	94,608
Site Studies	175,000	–	22,878	152,122
Completed Projects	9,599,999	9,599,999	–	–
	$227,008,434	$196,932,762	$ 9,557,369	$ 20,518,303
Underground Access				
Athabasca				
— U.T.F. Project	$ 61,281,948	$ 54,823,498	$ 3,091,270	$ 3,367,180
— Completed Projects	5,108,263	5,108,263	–	–
	$ 66,390,211	$ 59,931,761	$ 3,091,270	$ 3,367,180
Carbonate Trend				
Buffalo Creek				
— Union Oil	$ 31,335,000	$ 31,147,693	$ 80,747	$ 106,560
Completed Projects	308,082	308,082	–	–
	$ 31,643,082	$ 31,455,775	$ 80,747	$ 106,560
Heavy Oil				
Petro-Canada	$ 14,308,046	$ 13,892,625	$ (176)	$ 415,597
Alberta Energy Company	7,941,500	6,422,945	774,287	744,268
Norcen International Ltd.	6,750,000	5,842,095	(548,382)	1,456,287
PanCanadian Petroleum	1,500,000	761,214	207,119	531,667
Completed Projects	239,674	239,674	–	–
	$ 30,739,220	$ 27,158,553	$ 432,848	$ 3,147,819

Table 1

Oil Sands Technology and Research Fund
Summary of Funds Committed and Disbursed
As at March 31, 1989

Project	Funds Committed	Prior Years' Disbursements	Disbursements April 1/88 to March 31/89	Balance
Enhanced Recovery Conventional Oil				
Vikor Resources Ltd.	$ 4,900,000	$ 3,298,067	$ 931,941	$ 669,992
Hudson's Bay Oil & Gas	2,462,500	1,844,854	236,523	381,123
Robinson Slim Tube Test	169,240	123,608	32,382	13,250
Canterra's Solids Disposition Project	155,240	99,250	16,870	39,120
Saskatchewan Research Council	75,000	10,000	65,000	–
Westgrowth Petroleums Ltd.	600,000	556,500	–	43,500
P.R.I. EOR Initiatives Program	400,000	–	343,673	56,327
Gulf Canada Resources Ltd.	807,283	269,094	–	538,189
Bumper Horizontal Well	250,000	–	250,000	–
Pfizer Rundell Horizontal Well	800,000	–	–	800,000
Completed Projects	1,033,391	1,033,391	–	–
	$ 11,652,654	$ 7,234,764	$ 1,876,388	$ 2,541,502
Bitumen Upgrading				
Residue Utilization Project	$ 1,398,232	$ 1,182,506	$ 17,475	$ 198,251
VEBA OEL – Cold Lake	3,307,042	2,752,661	554,381	–
VEBA OEL – Athabasca	1,500,000	1,147,351	3,668	348,981
H.R.I.	1,656,200	1,440,803	145,855	69,542
Coal - Oil Processing	50,000	–	24,774	25,226
Completed Projects	17,944,566	17,907,582	36,984	–
	$ 25,856,040	$ 24,430,903	$ 783,137	$ 642,000
Technology Handling				
Database Administration	$ 4,153,515	$ 3,696,456	$ 122,285	$ 334,774
AOSTRA Journal	479,773	403,402	38,320	38,051
Patent Costs	770,000	602,620	110,252	57,128
AOSTRA Publication Series	28,500	9,800	5,695	13,005
AOSTRA Technical Handbook	100,000	5,219	31,130	63,651
Technology Transfer & Commercialization	500,000	44,108	157,866	298,026
Completed Projects	91,865	91,865	–	–
	$ 6,123,653	$ 4,853,470	$ 465,548	$ 804,635
Training Activities	$ 2,605,000	$ 1,802,012	$ 380,107	$ 422,881
International Activities	$ 1,880,800	$ 1,683,011	$ 167,161	$ 30,628
Authority Costs	$ 2,282,500	$ 2,014,857	$ 217,867	$ 49,776
Totals	$535,389,054	$468,931,313	$ 29,554,945	$ 36,902,796

Table 2

Oil Sands Technology and Research Fund
Statement of Revenue
Expenditure and Funds Balance

Fourteen-Year Summary
For the years ended March 31

	1989	1988	1987
Revenue			
Alberta General Revenue Fund	$ 26,100,000	$ 26,900,000	$ 34,700,000
Alberta Heritage Savings Trust Fund	9,900,000	20,800,000	31,400,000
Technology Sales	774,027	1,325,060	1,227,125
	$ 36,774,027	$ 49,025,060	$ 67,327,125
Expenditures			
Institutional Research			
Alberta Research Council			
— Information Centre — ALIS	$ 714,129	$ 699,180	$ 591,097
— Oil Sands Research Centre	1,312,005	1,430,990	1,972,980
— Sample Bank	144,000	153,423	155,588
— Regional Geological Program	497,521	464,075	517,955
— Hydrocarbon Program	388,600	374,383	773,341
— Strategic Research Program	1,586,666	1,588,050	1,249,256
— Marcro Energy Modelling	–	17,000	17,000
Inventors Assistance Grant	274,750	109,000	82,562
University Contracts	2,864,891	3,018,722	2,952,754
Professorships	743	91,120	411,389
New Graduate Assistance Program	201,518	65,750	7,847
Post Doctoral Fellowships	22,500	22,500	–
Scholarships and Fellowships	419,280	418,639	336,883
ARC Access Program	5,896	723	1,213
University Access Program	(2,930)	(95)	8,697
Program Planning and Evaluation	39,160	–	54,243
Petroleum Recovery Institute	700,000	700,000	1,000,000
Centre for Frontier Engineering Research	25,000	25,000	–
Computer Modelling Group	220,000	220,000	220,000
Unitar Conference	23,475	104,588	65,605
Unitar Management & Operations	110,092	–	–
Completed Projects	–	–	67,984
	$ 9,547,296	$ 9,503,048	$ 10,486,394

1986	1985	1984 and Prior	Total
$ –	$ –	$ –	$ 87,700,000
50,000,000	50,000,000	251,449,032	413,549,032
2,156,404	2,056,808	11,410,000	18,949,424
$ 52,156,404	$ 52,056,808	$ 262,859,032	$ 520,198,456
$ 499,620	$ 551,962	$ 2,640,579	$ 5,696,567
3,015,466	2,915,270	17,345,170	27,991,881
157,118	93,205	1,002,805	1,706,139
309,345	753,092	2,054,887	4,596,875
797,636	530,872	–	2,864,832
–	–	–	4,423,972
17,000	–	–	51,000
117,119	180,780	130,000	894,211
2,869,781	2,994,843	14,247,449	28,948,440
493,856	560,622	2,363,763	3,921,493
–	–	–	275,115
22,500	22,500	1,040	91,040
411,063	388,920	1,271,028	3,245,813
3,476	514	4,244	16,066
17,975	13,861	133,731	171,239
66,216	85,675	120,486	365,780
1,125,562	547,690	514,315	4,587,567
25,000	–	–	75,000
–	–	–	660,000
–	–	–	193,668
–	–	–	110,092
341,252	949,244	1,013,164	2,371,644
$ 10,289,985	$ 10,589,050	$ 42,842,661	$ 93,258,434

Table 2

Oil Sands Technology and Research Fund
Statement of Revenue
Expenditure and Funds Balance

Fourteen-Year Summary
For the years ended March 31

	1989	1988	1987
Mining and Extraction			
Retorting			
— UMATAC	$ 1,004,649	$ 1,378,265	$ 1,182,251
Nova/Husky/Canstar	–	33,152	121,129
Shell Canada/Solv-Ex	–	428,807	2,843,900
Terra Energy-Sesa Project	192,389	70,386	–
Tzipa Enterprizes-Ostex Process	81,457	9,918	–
Esso Resources	1,365,720	337,780	–
Syncrude Canada Limited	294,297	–	–
Completed Projects	16,695	–	890,685
	$ 2,955,207	$ 2,258,308	$ 5,037,965
In Situ Oil Sands			
Peace River			
— Shell	$ 175,484	$ 113,028	$ 12,299,010
Athabasca			
— Amoco	–	(27,148)	5,432
— Amoco/Petro-Canada	1,372,878	2,069,863	3,953,698
— Canterra Energy Ltd.	6,641,372	8,700,700	3,299,311
Cold Lake			
— B.P.	13,971	82,402	2,589,985
— B.P./Petro-Canada	–	–	35,349
— Bow Valley Industries	884,225	841,980	2,833,056
— Suncor - Ft. Kent	–	–	37,883
Alpha Engineering	2,100	1,000	–
Simtech Consulting	9,043	4,299	9,442
W.T.C. Water Treatment Project	34,599	340,400	–
Shell Water Treatment Project	–	678,297	–
Fekete Thermal Software Program	97,216	–	–
Simons Consulting - Coning Project	75,203	–	–
Maurer Drilling	42,126	–	–
Engineering Studies Program	186,274	19,118	–
Sites Studies	22,878	–	–
Completed Projects	–	–	19,045
	$ 9,557,369	$ 12,823,939	$ 25,082,211

1986	1985	1984 and Prior	Total
$ 2,460,548	$ 2,948,229	$ 8,778,933	$ 17,752,875
22,420	–	–	176,701
–	–	–	3,272,707
–	–	–	262,775
–	–	–	91,375
–	–	–	1,703,500
–	–	–	294,297
1,598,408	600,785	4,016,710	7,123,283
$ 4,081,376	$ 3,549,014	$ 12,795,643	$ 30,677,513
$ (1,572,687)	$ 806,095	$ 63,096,492	$ 74,917,422
(47,191)	(726,689)	24,588,123	23,792,527
2,013,365	5,854,969	71,721	15,336,494
3,063,138	15,199,377	6,210,228	43,114,126
2,692,069	3,474,113	15,095,426	23,947,966
281,730	192,092	640,978	1,150,149
2,397,730	5,663,,041	351,550	12,971,582
(9,284)	75,739	14,641	118,979
–	–	–	3,100
18,890	–	–	41,674
–	–	–	374,999
–	–	–	678,297
–	–	–	97,216
–	–	–	75,203
–	–	–	42,126
–	–	–	205,392
–	–	–	22,878
108,218	1,565,372	7,907,365	9,600,000
$ 8,945,978	$ 32,104,109	$ 117,976,524	$ 206,490,130

Table 2

Oil Sands Technology and Research Fund
Statement of Revenue
Expenditure and Funds Balance

Fourteen-Year Summary
For the years ended March 31

	1989	1988	1987
Underground Access			
Athabasca			
— U.T.F. Project	$ 3,091,270	$ 3,764,839	$ 11,248,413
— Completed Projects	–	–	–
	$ 3,091,270	$ 3,764,839	$ 11,248,413
Carbonate Trend			
Buffalo Creek			
— Union Oil	$ 80,747	$ 255,743	$ 2,860,676
Completed Projects	–	–	137
	$ 80,747	$ 255,743	$ 2,860,813
Heavy Oil			
Petro-Canada	$ (176)	$ (29,809)	$ 314,067
Alberta Energy Company	774,287	165,875	585,204
Norcen International Ltd.	(548,382)	(1,188,165)	6,914,180
PanCanadian Petroleum	207,119	66,140	145,688
Completed Projects	–	–	–
	$ 432,848	$ (985,959)	$ 7,959,139
Enhanced Recovery Conventional Oil			
Vikor Resources Ltd.	$ 931,941	$ (22,200)	$ 484,889
Hudson's Bay Oil & Gas	236,523	277,211	129,714
Robinson Slim Tube Test	32,382	116,049	7,559
Canterra's Solids Disposition Project	16,869	18,037	81,213
Saskatchewan Research Council	65,000	10,000	–
Westgrowth Petroleums Ltd.	–	(43,500)	600,000
P.R.I. EOR Initiatives Program	343,673	–	–
Gulf Canada Resources Ltd.	–	269,094	–
Bumper Horizontal Well	250,000	–	–
Completed Projects	–	–	2,875
	$ 1,876,388	$ 624,691	$ 1,306,250

1986	1985	1984 and Prior	Total
$ 15,691,395	$ 19,452,415	$ 4,666,435	$ 57,914,767
–	–	5,108,264	5,108,264
$ 15,691,395	$ 19,452,415	$ 9,774,699	$ 63,023,031
$ 2,234,802	$ 4,380,864	$ 21,415,608	$ 31,228,440
307,439	506	–	308,082
$ 2,542,241	$ 4,381,370	$ 21,415,608	$ 31,536,522
$ 316,747	$ 1,541,199	$ 11,750,423	$ 13,892,451
422,242	349,412	4,900,213	7,197,233
17,664	9,613	88,802	5,293,712
99,194	334,175	116,017	968,333
–	56,470	183,202	239,672
$ 855,847	$ 2,290,869	$ 17,038,657	$ 27,591,401
$ (698,262)	$ (1,036,981)	$ 4,570,621	$ 4,230,008
1,437,929	–	–	2,081,377
–	–	–	155,990
–	–	–	116,119
–	–	–	75,000
–	–	–	556,500
–	–	–	343,673
–	–	–	269,094
–	–	–	250,000
1,476	(6,439)	1,035,479	1,033,391
$ 741,143	$ (1,043,420)	$ 5,606,100	$ 9,111,152

Table 2

Oil Sands Technology and Research Fund
Statement of Revenue
Expenditure and Funds Balance

Fourteen-Year Summary
For the years ended March 31

	1989	1988	1987
Bitumen Upgrading			
Residue Utilization Project	$ 17,475	$ 161,169	$ 210,187
VEBA OEL - Cold Lake	554,381	2,384,530	368,131
VEBA OEL - Athabasca	3,668	1,147,351	–
H.R.I.	145,855	–	1,440,803
Coal - Oil Processing	24,774	–	–
Completed Projects	36,984	–	7,892,461
	$ 783,137	$ 3,693,050	$ 9,911,582
Technology Handling			
Data Base Administration	$ 122,285	$ 240,945	$ 498,062
AOSTRA Journal	38,320	46,185	45,310
Patent Costs	110,252	102,620	15,730
AOSTRA Publication Series	5,695	9,800	–
AOSTRA Technical Handbook	31,130	5,000	–
Technology Transfer & Commercialization	157,866	44,108	–
Completed Projects	–	–	–
	$ 465,548	$ 448,658	$ 559,102
Training Activities	$ 380,107	$ 42,364	$ 219,758
International Activities	$ 167,161	$ 77,930	$ 71,687
Authority Costs	$ 217,867	$ 298,554	$ 448,223
	$ 29,554,945	$ 32,805,165	$ 75,191,537
Excess of Revenue over Expenditures	$ 7,219,082	$ 16,219,895	$ (7,864,412)
Fund Balance at Beginning of Period	$ 14,493,117	$ (1,726,778)	$ 6,137,634
Fund Balance at End of Period	$ 21,712,199	$ 14,493,117	$ (1,726,778)

1986	1985	1984 and Prior	Total
$ 255,100	$ 521,675	$ 34,375	$ 1,199,981
–	–	–	3,307,042
–	–	–	1,151,019
–	–	–	1,586,658
–	–	–	24,774
4,396,543	591,994	5,026,584	17,944,566
$ 4,651,643	$ 1,113,669	$ 5,060,959	$ 25,214,040
$ 480,930	$ 502,730	$ 1,973,788	$ 3,818,740
149,749	124,471	37,687	441,722
62,851	68,142	353,277	712,872
–	–	–	15,495
219	–	–	36,349
–	–	–	201,974
–	–	91,865	91,865
$ 693,749	$ 695,343	$ 2,456,617	$ 5,319,017
$ 270,129	$ 243,757	$ 1,026,005	$ 2,182,120
$ 109,690	$ 444,666	$ 979,039	$ 1,850,173
$ 471,612	$ 37,726	$ 758,742	$ 2,232,724
$ 49,344,788	$ 73,858,568	$ 237,731,254	$ 498,486,257
$ 2,811,616	$ (21,801,760)	$ 25,127,778	$ 21,712,199
$ 3,326,018	$ 25,127,778	–	–
$ 6,137,634	$ 3,326,018	$ 25,127,778	$ 21,712,199

Auditor's Report
and
Financial Statements

Alberta Oil Sands
Technology and Research Authority
Oil Sands Technology and Research Fund
Financial Statements
March 31, 1989

Auditor's Report

Balance Sheet

**Statement of Revenue,
Expenditure and Fund Balance**

**Notes to the
Financial Statements**

ALBERTA LEGISLATURE

OFFICE OF THE AUDITOR GENERAL

AUDITOR'S REPORT

To the Members of the Alberta Oil
Sands Technology and Research Authority

I have examined the balance sheet of the Alberta Oil Sands Technology and Research Authority - Oil Sands Technology and Research Fund as at March 31, 1989 and the statement of revenue, expenditure and fund balance for the year then ended. My examination was made in accordance with generally accepted auditing standards, and accordingly included such tests and other procedures as I considered necessary in the circumstances.

In my opinion, these financial statements present fairly the financial position of the Fund as at March 31, 1989 and the results of its operations and the changes in its financial position for the year then ended in accordance with generally accepted accounting principles applied on a basis consistent with that of the preceding year.

Donald D. Salmon

FCA
Auditor General

Edmonton, Alberta
June 16, 1989

Alberta Oil Sands Technology and Research Authority
Oil Sands Technology and Research Fund

Balance Sheet

As At March 31, 1989

ASSETS	1989	1988
Current:		
Cash	$26,577,835	$15,164,220
Deposits on projects, net (Note 3)	1,581,362	297,321
Accounts receivable	2,028,942	4,779,356
	$30,188,139	$20,240,897

LIABILITIES AND FUND BALANCE		
Current:		
Accounts payable	$ 7,487,205	$ 4,842,344
Holdbacks payable	988,735	905,436
	8,475,940	5,747,780
Fund balance	21,712,199	14,493,117
	$30,188,139	$20,240,897

The accompanying notes are part of these financial statements.

Alberta Oil Sands Technology and Research Authority
Oil Sands Technology and Research Fund

Statement of Revenue, Expenditure and Fund Balance

For the Year Ended March 31, 1989

	1989	1988
Revenue:		
Contributions by the Province of Alberta:		
– General Revenue Fund	$ 26,100,000	$ 26,900,000
– Heritage Savings Trust Fund	9,900,000	20,800,000
Technology sales	774,027	1,325,060
	36,774,027	49,025,060
Expenditure:		
In situ oil sands, net (Notes 4 and 5)	9,557,369	12,823,939
Institutional research	9,547,296	9,503,048
Underground access (Note 5)	3,091,270	3,764,839
Mining and extraction	2,955,207	2,258,308
Enhanced recovery (Note 4)	1,876,388	624,691
Bitumen upgrading	783,137	3,693,050
Technology handling	465,548	448,658
Heavy oil, net (Notes 4 and 5)	432,848	(985,959)
Training activities	380,107	42,364
Authority costs	217,867	298,554
International activities	167,161	77,930
Carbonate trend	80,747	255,743
	29,554,945	32,805,165
Excess of revenue over expenditure for the year	7,219,082	16,219,895
Fund balance (deficit) at beginning of year	14,493,117	(1,726,778)
Fund balance at end of year	$21,712,199	$14,493,117

Notes to the Financial Statements

March 31, 1989

Note 1 Authority

The Alberta Oil Sands Technology and Research Authority operates under the authority of the Oil Sands Technology and Research Authority Act, Chapter 0-6, Revised Statutes of Alberta 1980.

Note 2 Significant Accounting Policies and Reporting Practices

Expenditures from the Fund are not capitalized due to the intangible nature of assets that may accrue to the Authority. The Authority will be entitled to share in any assets remaining at the end of a project in proportion to its percentage of participation. Interest earned on cash balances is credited to the General Revenue Fund, and is not reflected in these financial statements. A statement of changes in financial position is not provided as disclosure in these financial statements is considered to be adequate.

Note 3 Deposits on Projects

The amount of $1,581,362 (1988 $297,321) shown on the balance sheet represents the net excess of cash calls on projects over actual expenditures.

Note 4 Potential Recoveries

The following amounts represent potential future recoveries:

	1989	1988
Shell Canada Resources Limited (In situ oil sands)		
— PRISP Project	$12,200,000	$12,200,000
— Sale of 50% interest in PRISP Project	12,200,000	12,200,000
Norcen International (Heavy oil) —		
BODO Steam Pilot Project	5,290,000	5,800,000
Vikor Resources (Enhanced recovery) —		
Joffre Project	4,200,000	3,300,000
	$33,890,000	$33,500,000

Recovery of these amounts is dependent on generation of sufficient recoveries by the projects. Due to the uncertainty concerning the amount of revenue which may ultimately be generated, these amounts have not been included as a receivable in these financial statements and will be offset against expenditures in the year of receipt.

Note 5 Reduction of Expenditure

Current year expenditure has been reduced as follows:

a) In situ oil sands has been reduced by sales of project production as defined in agreements.

b) Underground access has been reduced by $2,000,000 (1988 $4,520,870), the amount received from participants in the UTF project.

c) Heavy oil has been reduced by sales of project production as defined in agreements and recoveries of $550,000 (1988 $1,190,000) from Norcen International.

Note 6 Commitments

The Authority had outstanding commitments as at March 31, 1989 totalling $36,902,796 (1988 $38,260,676) for approved projects.

Note 7 Contingent Liabilities

The Authority is involved in a number of legal proceedings. Claims against the Authority in these proceedings, which have not been reflected in the financial statement, amount to approximately $57,000,000. While the ultimate outcome of these proceedings cannot be determined at this time, it is the opinion of management that the disposition of these cases will have a minor effect on the financial position of the Authority.

Note 8 Administration Costs

The following costs incurred in the administration of the Authority have been borne by the General Revenue Fund and are not reflected in these financial statements.

	1989	1988
Salaries and wages	$2,063,691	$2,218,362
Rental of property and equipment	373,295	379,285
Employee benefits	302,650	306,430
Fees and commissions	246,040	323,430
Travelling and hospitality	198,815	151,985
Materials and supplies	92,745	63,942
Staff relocation costs	33,300	-
Freight, express and postage	19,907	8,235
Furniture and equipment purchases	16,735	9,694
Equipment maintenance	16,647	7,907
Telephone and telegraph	15,851	13,670
Advertising	9,171	8,774
Grants	7,450	2,600
Insurance premiums	3,935	-
	$3,400,232	$3,494,314

Note 9 Approval of Financial Statements

These financial statements were approved by management.